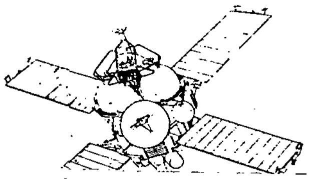
NEWS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

TELS. WO 2-4155
WO 3-6925

FOR RELEASE: FRIDAY A.M.
April 30, 1971

RELEASE NO: 71-75



PROJECT: MARINER MARS 1971

(NASA-News-Release-71-75) MARINER MARS 1971: PRESS KIT R.T. Mittauer (NASA) 30 Apr. 1971 63 p CSCL 22A

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NEWS NASA NATIONAL AERONAUTICS AND SPACE ADMINISTRATION WASHINGTON, D.C. 20546 TELS: (202) 962-4155 (202) 963-6925

FOR RELEASE: FRIDAY A.M.
April 30, 1971

Phone: 202/962-1176
(Richard T. Mittauer)

RELEASE NO: 71-75

MARINER MARS 1971 LAUNCHES

The eighth and ninth in the Mariner series of spacecraft are being prepared at Cape Kennedy, FL, for the National Aeronautics and Space Administration's first attempt to orbit another planet - Mars.

Mariner H has been mated to Atlas-Centaur 24 and is awaiting a launch window no earlier than 9:29 p.m. EDT, May 7. Mariner I will be mated to Atlas-Centaur 23 after AC-24 lifts-off, for launch no earlier than 7:57 p.m. EDT, May 17.

Arrival dates at Mars will be Nov. 14 and 24, when each spacecraft will begin a basic mission of 90 days in orbit around the planet. If one or both spacecraft survive that period, an extended mission to last up to one year is being considered.

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The objectives of the Mariners are to study the surface and atmosphere of Mars in detail and over a period of time, to provide a broad picture of the history of the planet and natural processes currently shaping the Martian environment.

To accomplish these, one spacecraft will map 70% of the planet and the other will repeatedly study selected areas on Mars to observe changes on the surface and in the atmosphere. Recurring phenomena such as dust storms, clouds and seasonal changes in the appearance of the planet's surface have been observed on Mars. The orbital missions will allow scientists to study these phenomena daily at close range.

The Mariners will carry identical payloads of instruments to allow each spacecraft to conduct six scientific investigations:

- Martian topography and variable features with two television cameras, one with a wide-angle lens and one with a telephoto lens;

- surface temperature measurements with an infrared radiometer;

- composition and structure of the atmosphere with an ultraviolet spectrometer;

- studies of the planet's surface and composition and temperature of its atmosphere with an infrared interferometer spectrometer;

- atmospheric pressure and structure with an S-Band occultation experiment;

- and a more accurate description of Mars' gravity field and the orbits of its two moons, and an improved ephemeris of Mars (its position in its solar orbit at a given time).

The latter two experiments involve measurements of the Mariners' radio signals back to Earth and do not require special instruments on the spacecraft.

The scientific experiments have been teamed together to provide a maximum of correlation of the data they gather. The three instruments on the scan platform, for instance, are bore-sighted with the television cameras so that the photography can be correlated with measurements of the Martian atmospheric and surface characteristics.

The two Mariners will work as a team performing different but complementary missions. Mariner H has been assigned Mission A, a mapping mission. Mariner I has been assigned Mission B, a variable features study. If one spacecraft fails at any time up to five days before orbital insertion, the mission of the second spacecraft will be revised to perform significant parts of both missions.

Mariner H (Mission A, mapping) will orbit Mars once each 12 hours, inclined 80 degrees to the Martian equator, with a 10,000-mile (17,300-kilometer) high point in the orbit (apoapsis) and a 750-mile (1,250-kilometer) low point (periapsis).

Mariner I (Mission B, variable features) will orbit in 20 and one half hours, inclined 50 degrees, with an apoapsis of 20,500 miles (28,600 kilometers) and periapsis of 530 miles (850 kilometers). This orbit will allow the spacecraft to observe selected areas of Mars repeatedly every five days or six orbits.

The spacecraft will each weigh approximately 2,200 pounds (1,000 kilograms) at launch, with about 1,000 pounds (454 kilograms) of fuel for the 300-pound thrust retroengine. After injection into Mars orbit, the spacecraft will weigh approximately 1,200 pounds (544 kilograms).

Orbit insertion will require about a 14-minute burn of the retroengine slowing the spacecraft by about 3,250 miles-per-hour (1,450 meters-per-second). The spacecraft velocity relative to Mars prior to the burn will be about 11,000 mph (4,920 m/sec).

The launches will be direct ascent without a parking orbit. The launch aiming point will be at such a distance from Mars as to insure that neither spacecraft nor the Centaur second stage will impact Mars in the event of loss of control during the launch phases. The orbits of the two spacecraft are designed to guarantee that they will not impact Mars for at least 17 years, to avoid contamination of the planet before studies are conducted on the surface by landing spacecraft.

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Following successful injection into solar orbit, two midcourse maneuvers may be performed to correct the trajectory and refine the aiming point. The retroengine will be used for midcourse maneuvers.

The accuracy required to orbit Mars is unprecedented in a flight into deep space. The aiming zone at the end of the 287-million-mile (462-million-kilometer) flight is an area about 435 miles (1,165 kilometers) square.

After insertion into Mars orbit, the spacecraft will be tracked for a sufficient period to determine the orbital corrections (trims) required to yield precise orbits. The trims will be provided by the retroengine.

The maximum data transmission rate will be 16,200 bits-per-second when the spacecraft can transmit to the sensitive 210-foot (64-meter) antenna at the Goldstone station of the Deep Space Network in the California Mojave Desert. Other stations will receive at a maximum rate of 2,025 bits-per-second.

NASA's Office of Space Science and Applications assigned project responsibility including mission operations and tracking and data acquisition to the Jet Propulsion Laboratory managed by the California Institute of Technology. The launch vehicle is the responsibility of the Lewis Research Center, Cleveland. The contractor to Lewis is General Dynamics/Convair, San Diego.

Tracking and communications is assigned to the Deep Space Net operated by JPL for NASA's Office of Tracking and Data Acquisition.

Cost of the basic 90-day Mariner Mars '71 mission is $129 million, exclusive of launch vehicles and data acquisition.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)

MISSION CAPSULE

Two Mariner spacecraft to be launched to Mars in May, 1971.

Arrive Mars on November 14 and 24, 1971. Flight time approximately 190-days. Distance travelled, 287 million miles (462 million kilometers).

Mission - to orbit Mars for 90-days.

Spacecraft launch weight 2,200 lbs. (1,000 kg.). Weight in orbit, 1,200 lbs. (544 kg.).

Launch vehicle, Atlas/Centaur. Direct ascent launch.

Experiments:

1. Two television cameras, one narrow angle and one wide angle.

2. Infrared radiometer.

3. Ultraviolet spectrometer.

4. Infrared interferometer spectrometer.

5. Celestial mechanics.

6. Occultation. The latter two experiments do not require special instruments.

MARINER H MISSION A	-	*Map 70% of Mars at medium resolution and* provide 5% coverage at high resolution.
MARINER I MISSION B	-	Study surface features and atmosphere as they change in time.
MARINER H A ORBIT	-	10,000 miles (17,256 kilometers) apoapsis to 750 miles (1,250 kilometers) periapsis. Inclination, 80 degrees. Period is 12 hours.
MARINER I B ORBIT	-	20,500 miles (28,579 kilometer) apoapsis to 530 miles (850 kilometer) periapsis. Inclination, 50 degrees. Period is 20 1/2 hours.

MARINER PLANETARY MISSIONS

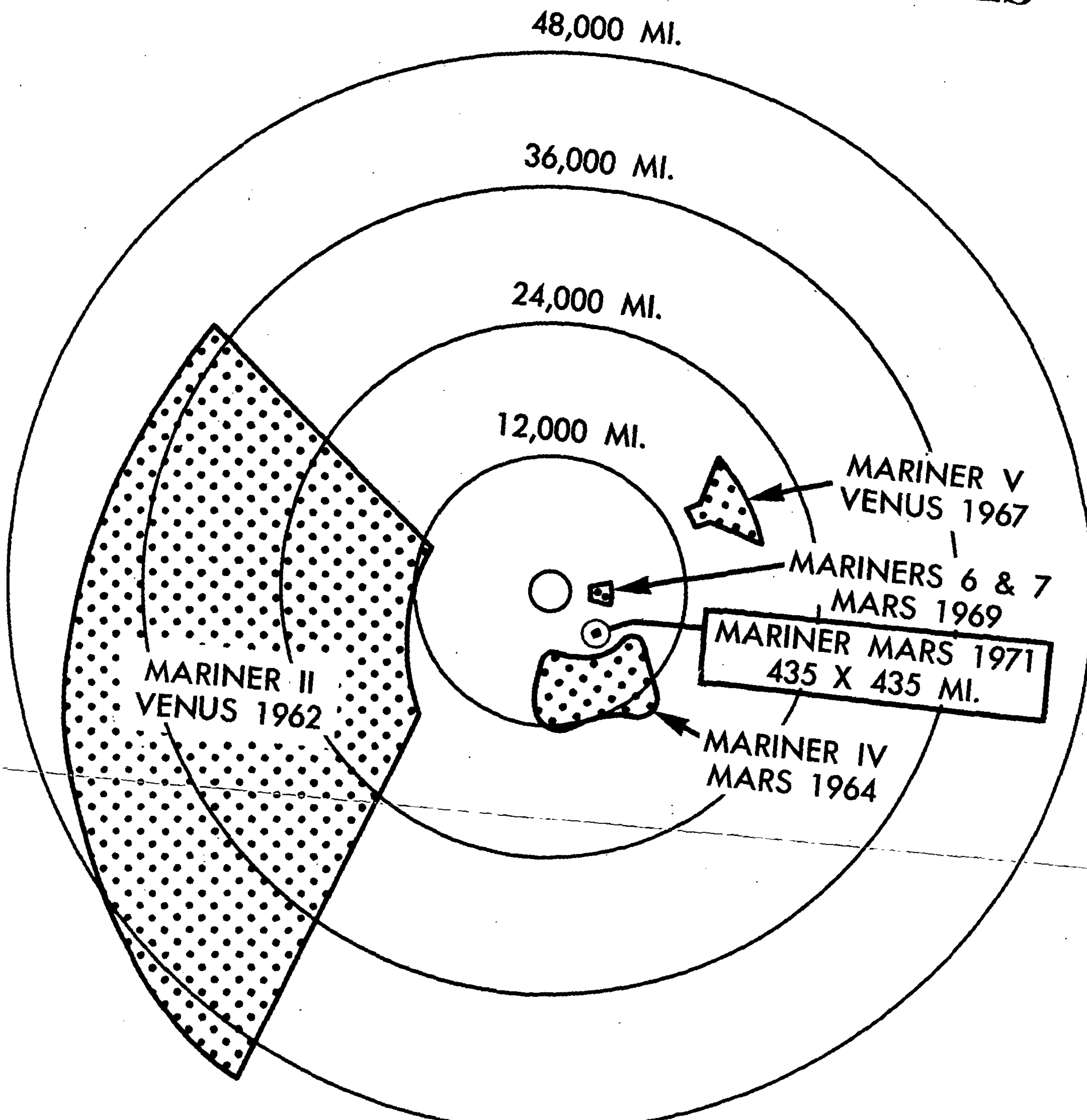
	'71 MARS ORBITERS		MARINERS 6 & 7 '69 MARS (FLY-BY)	MARINER 5 '67 VENUS (FLY-BY)	MARINER 4 '65 MARS (FLY-BY)	MARINER 2 '62 VENUS (FLY-BY)
Spacecraft Weight pounds (kilograms)	Launch:	2,200 (1,000)	847 (384)	539 (245)	575 (261)	447 (203)
	In Orbit.	1,200 (544)				
Closest Approach to Planet miles (kilograms)	Mission A:	750 (1,200)	2,100 (3,380)	2,544 (4,100)	6,118 (9,850)	21,594 (34,700)
	Mission B:	530 (854)				
Distance from Earth at Target million miles (million kilometers)	MISSION A:		62 (100)	50 (80)	134 (216)	36 (58)
	Encounter:	76 (122)				
	E+90 Days:	146 (235)				
	MISSION B: 84 (135) 154 (248)					
Communication Time (one-way)	Encounter:	Approx. 7 Minutes	5 Minutes 22 Seconds	4 Minutes 26 Seconds	12 Minutes 1 Second	3 Minutes 14 Seconds
	E+90 Days:	Approx. 13 Minutes				
Time-of-Flight	Mission A:	194 Days	156-130 Days	127 Days	228 Days	109 Days
	Mission B:	192 Days				

MARINER PLANETARY MISSIONS

	'71 MARS ORBITERS	MARINERS 6 & 7 '69 MARS (FLY-BY)	MARINER 5 '67 VENUS (FLY-BY)	MARINER 4 '65 MARS (FLY-BY)	MARINER 2 '62 VENUS (FLY-BY)
Maximum Communication Distance million miles (million kilometers)	154 (248)	250 (402)	82 (132)	216 (348)	54 (87)
Maximum Data Transmission Rates	16,200 bits per second	16,200 bps	33 1/3 bps	33 1/3 bps	33 1/3 bps

NOTE: The Mariner 1 and 3 missions were unsuccessful because of launch vehicle failures.

MARINER AIMING ZONES



MISSIONS

There are two missions to be performed at Mars each with specific objectives and a specific orbit. Should one Mariner spacecraft fail, the other will combine as many of the objectives of both missions as possible.

Mariner H - Mapping Mission A

The objective of this mission is to map 70 per cent of Mars at a resolution of 3,280 feet (1,000 meters). High resolution photographs at a resolution of 328 feet (100 meters), nesting inside the wide-angle photographs, will cover 5 per cent of the surface.

The orbital period for the mapping mission will be fixed at 12 hours. This will allow twice-daily observations near periapsis each with a subsequent transmission of recorded data at the high bit rate of 16,200 bits per second to the 210-foot (64-meter) antenna of the Deep Space Network at Goldstone.

Following insertion into orbit, the spacecraft will be tracked for a sufficient period to allow calculation of required trimming of the orbit to secure the precise orbit desired.

In a typical orbit the spacecraft will:

1. Playback data in its tape recorder (this requires three hours) taken on the previous orbit,

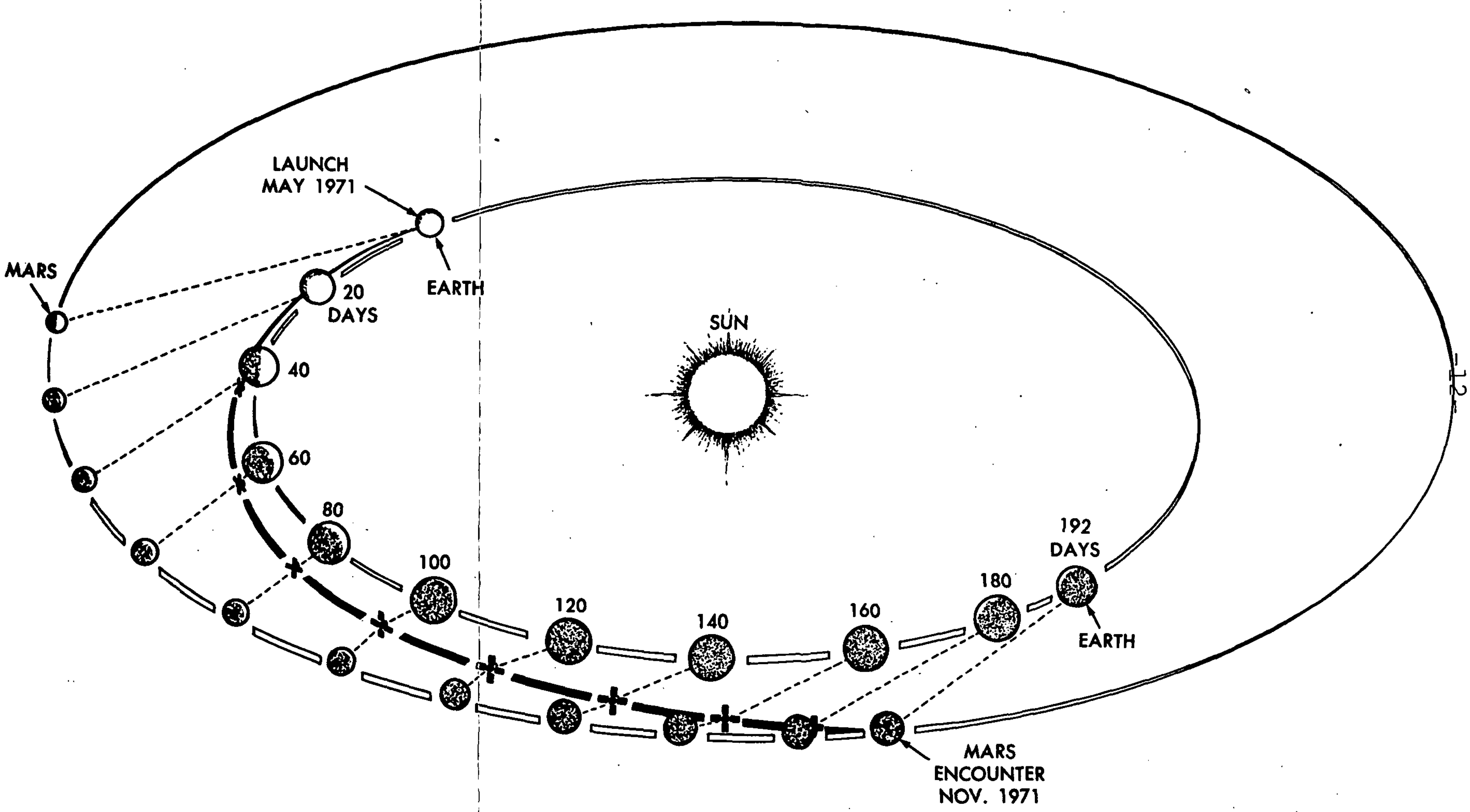
2. Take TV, infrared and ultraviolet data for storage on the tape recorder (IR and UV data is also transmitted in real time at 8,000 bits per second when the large Goldstone antenna can be used);

3. Enter the occultation zone shortly after the recorder is filled;

4. Following occultation, the spacecraft will still be in view of Goldstone and the recorded data is transmitted.

On the next orbit, Goldstone is not in view. The recorder is filled again and the data held until the following orbit.

MARINER FLIGHT PATH TO MARS



Because the orbital period is 12 hours and the rotation rate of Mars is about 24 hours 37 minutes, the planet will rotate slightly less than 180 degrees per spacecraft orbit. Mapping coverage, therefore, will alternate from one side of the planet to the other. A complete mapping circuit around Mars will be completed in about 20 days. After 90 days, the area between -60 and +40 degrees latitude will have been covered.

Areas of specific interest can be re-examined every 20 days with the full array of instruments allowing opportunity for adaptive operations, making use of previous data to plan operations.

After 90 to 100 days in orbit, depending on the actual performance of the high-rate channel, the increasing Earth-Mars distance and the spacecraft antenna orientation will cause the tape playback rate to be dropped to 8,100 bits per second, even with the use of the 210-foot (64-meter) antenna. At that time, either a full tape recorder of data will be taken on every other orbit or half the amount of data will be taken on each orbit.

Several days later data rates will have to be further reduced, as the main lobe of the spacecraft antenna beam moves away from Earth, until data rates of 4,000 bits or 2,000 bits per second stabilize for extended operations.

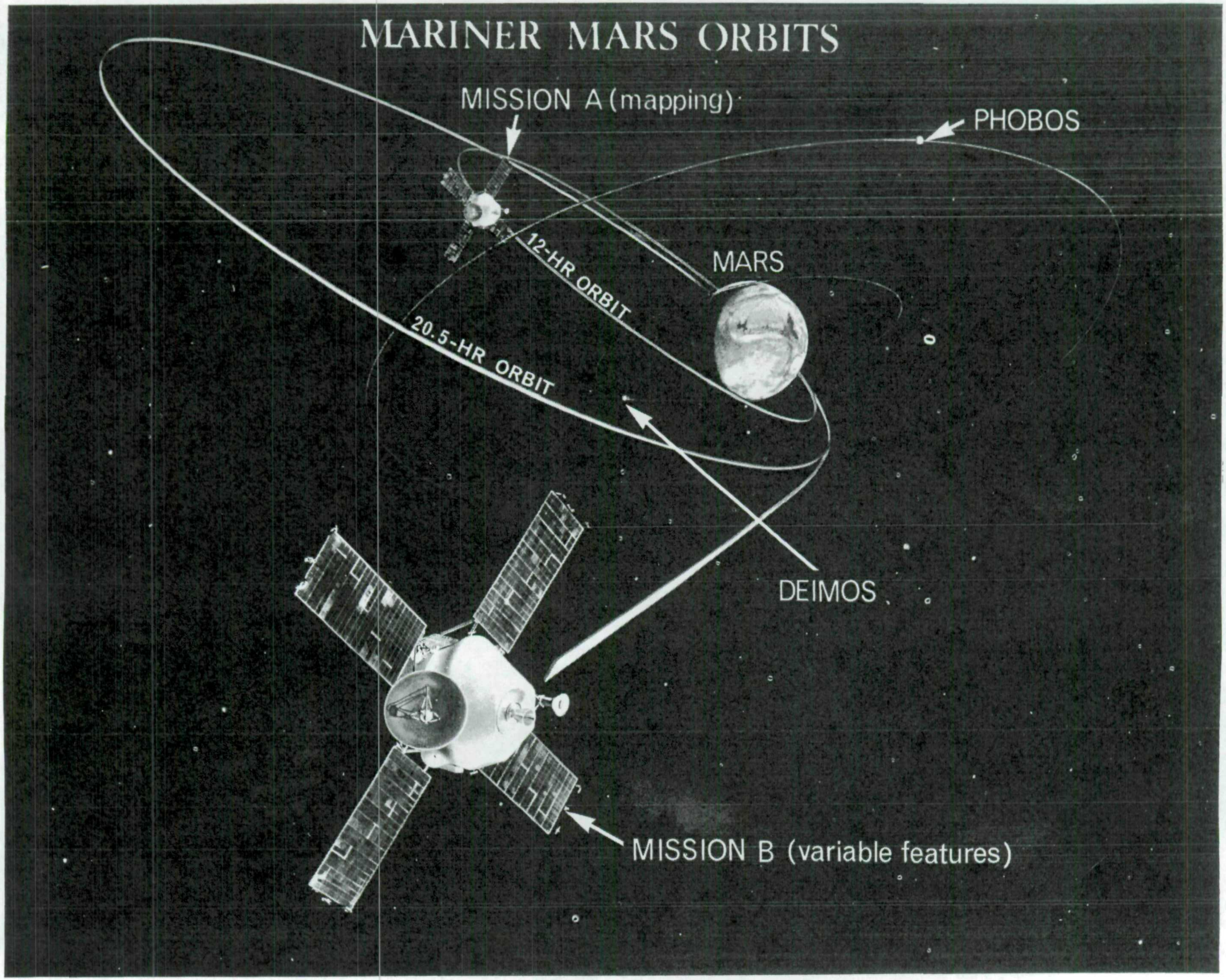
<u>Mariner I - Variable Features Mission B</u>

The objective of this mission is to study changes on the surface and in the atmosphere of Mars over a period of time.

The period of the orbit, 20.5 hours, was selected to provide repeated studies of a series of six adjacent sites girdling the planet in five days.

The relationship between the spacecraft orbital period of 20 1/2 hours and Mar's rotational period of 24 hours 37 minutes, places the cameras over the six adjacent areas in six orbits. Repeat coverage begins with the seventh orbit at the beginning of the sixth day.

The time relationship is achieved by selecting a spacecraft velocity resulting in an orbit with a high point of 20,000 miles (28,579 kilometers) and a low point of 530 miles (850 kilometers).


MARINER MARS ORBITS
MISSION A (mapping)
PHOBOS
12-HR ORBIT
MARS
20.5-HR ORBIT
DEIMOS
MISSION B (variable features)

A typical orbit will provide full disc coverage, high Sun angle photography for albedo studies, low and high resolution studies by the infrared and ultraviolet instruments, Earth occultation, and dark side UV and IR data.

The two moons of Mars, Phobos and Deimos, may be mapped by the television experiment and probed by the infrared and ultraviolet experiments.

Observations of starfields and Saturn also may be used to calibrate the cameras.

It is planned, when possible, to use an adaptive mode in planning science operations from orbit. In this mode, an interesting feature seen in previous photographs can be specifically re-examined in subsequent passes that cover that area. It is also possible, depending on the amount of fuel remaining after attaining orbit, to change a spacecraft orbit to repeatedly cover an area of unusual activity or significance.

MARINER SPACECRAFT

The Mariner Mars 1971 spacecraft were designed, assembled and tested by the Jet Propulsion Laboratory, Pasadena. Industrial contractors provided the detailed design and fabrication of most of the subsystems. Component parts were provided by hundreds of manufacturers and suppliers.

Design of the spacecraft is based on continuing Mariner technology and on the 1969 Mariner 6 and 7 spacecraft in particular.

Mariner's basic structure is a 40-pound (18.15 kilogram) eight-sided forged magnesium framework with eight electronics compartments. The compartments themselves provide structural support to the spacecraft.

Four solar panels, each 84 1/2 inches (2.14 meters) long and 35 1/2 inches (0.902 meters) wide, are attached by out-rigger structures to the top or sunward side of the octagon. Each panel has a solar cell area 20.7 feet (1.92 meters) square, or a total cell surface of approximately 83 square feet (7.8 square meters) for each spacecraft.

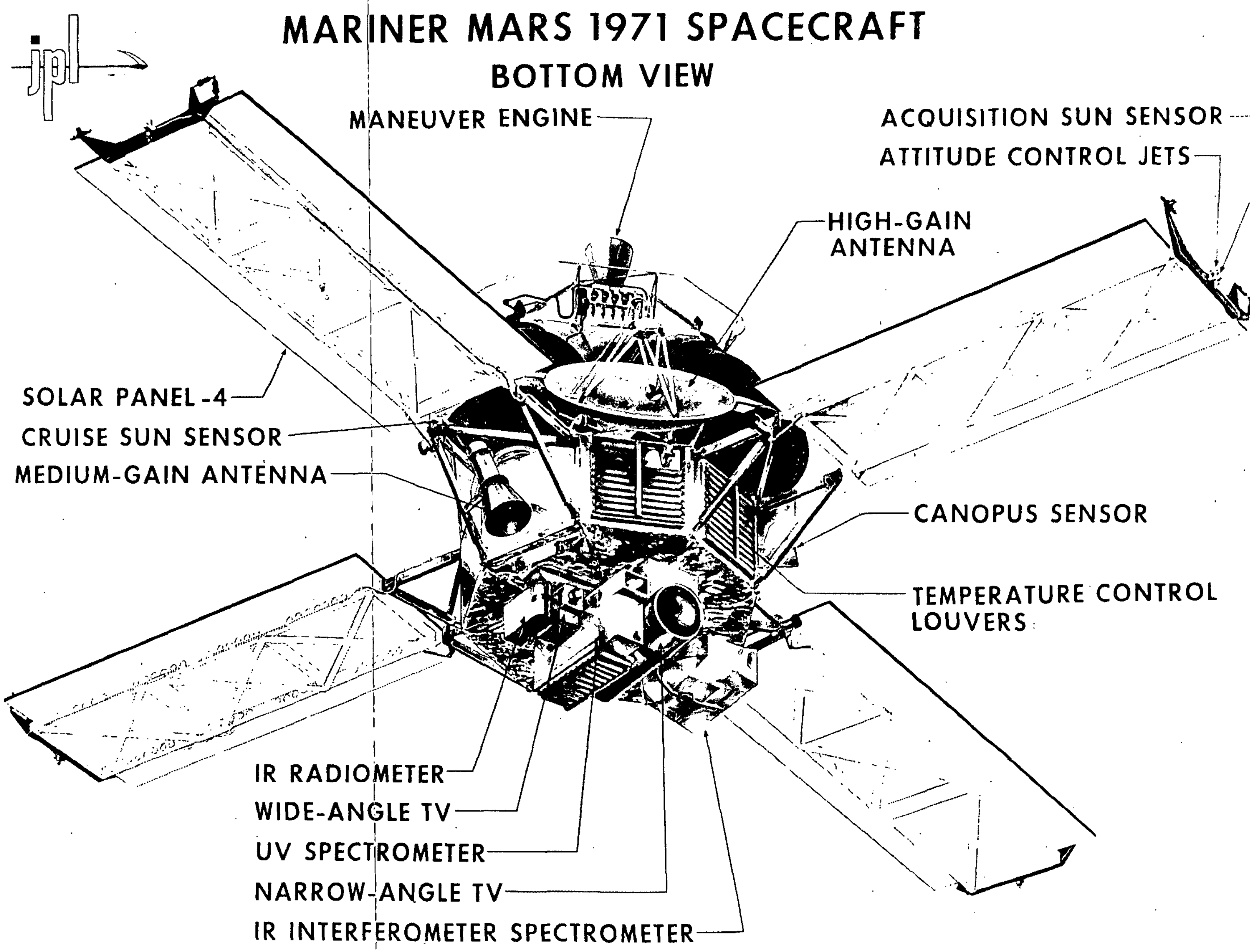
Two sets of attitude control jets consisting of six jets each, which stabilize the spacecraft on three axes, are mounted at the tips of the four solar panels. Titanium bottles containing the nitrogen gas supply for Mariner's dual attitude control gas system and regulators for the systems are mounted on the top ring of the octagon.

Two spherical propellant tanks for the liquid-fueled rocket engine are mounted side by side atop the octagonal structure with the rocket nozzle protruding between the tanks. The titanium tanks are 30 inches (0.762 meters) in diameter.

The two-position high-gain antenna is attached to the spacecraft by a superstructure atop the octagon. Its aluminum honeycomb dish reflector is circular, 40 inches (1.02 meters) in diameter, and is parabolic in cross-section. The antenna feed is supported at the focus of the parabola by a fiberglass truss. The two-position capability allows the Earth to be centered in the antenna beam during both pre-orbit and the orbital periods of the mission.

The low-gain omnidirectional antenna is mounted at the top of a circular aluminum tube, four inches (10.2 centimeters) in diameter and extending vertically 57 inches (1.45 meters) from the top of the octagonal structure. The tube acts as a waveguide for the antenna.

MARINER MARS 1971 SPACECRAFT
BOTTOM VIEW



NOTE: PROPULSION MODULE AND SCAN PLATFORM INSULATION BLANKETS NOT SHOWN

A horn-shaped medium-gain antenna is mounted on a solar panel outrigger so that it is pointed toward Earth during spacecraft insertion into Mars orbit.

The Canopus star tracker assembly is located on the upper ring structure of the octagon for a clear field of view between two solar panels. The cruise Sun sensor and Sun gate are attached to a solar panel outrigger.

The eight electronics compartments girdling the spacecraft house the following: Bay 1, power regulators; Bay 2, power conversion equipment, scan control and IRIS electronics; Bay 3, Central Computer and Sequencer and attitude control sub-system; Bay 4, flight telemetry and command subsystems; Bay 5, tape recorder; Bay 6, radio receiver and transmitters; Bay 7, television electronics and data automation subsystem; Bay 8, spacecraft battery.

Six of the electronics compartments are temperature controlled by lightweight louver assemblies on the outer surfaces. The octagon's interior is insulated by multilayer fabric thermal blankets at both top and bottom of the structure.

To avoid puncture of the propellant tanks by micrometeoroids, the outer layer of the top thermal blanket is constructed of a tightly-woven fiberglass cloth (Armalon) designed to break up striking particles.

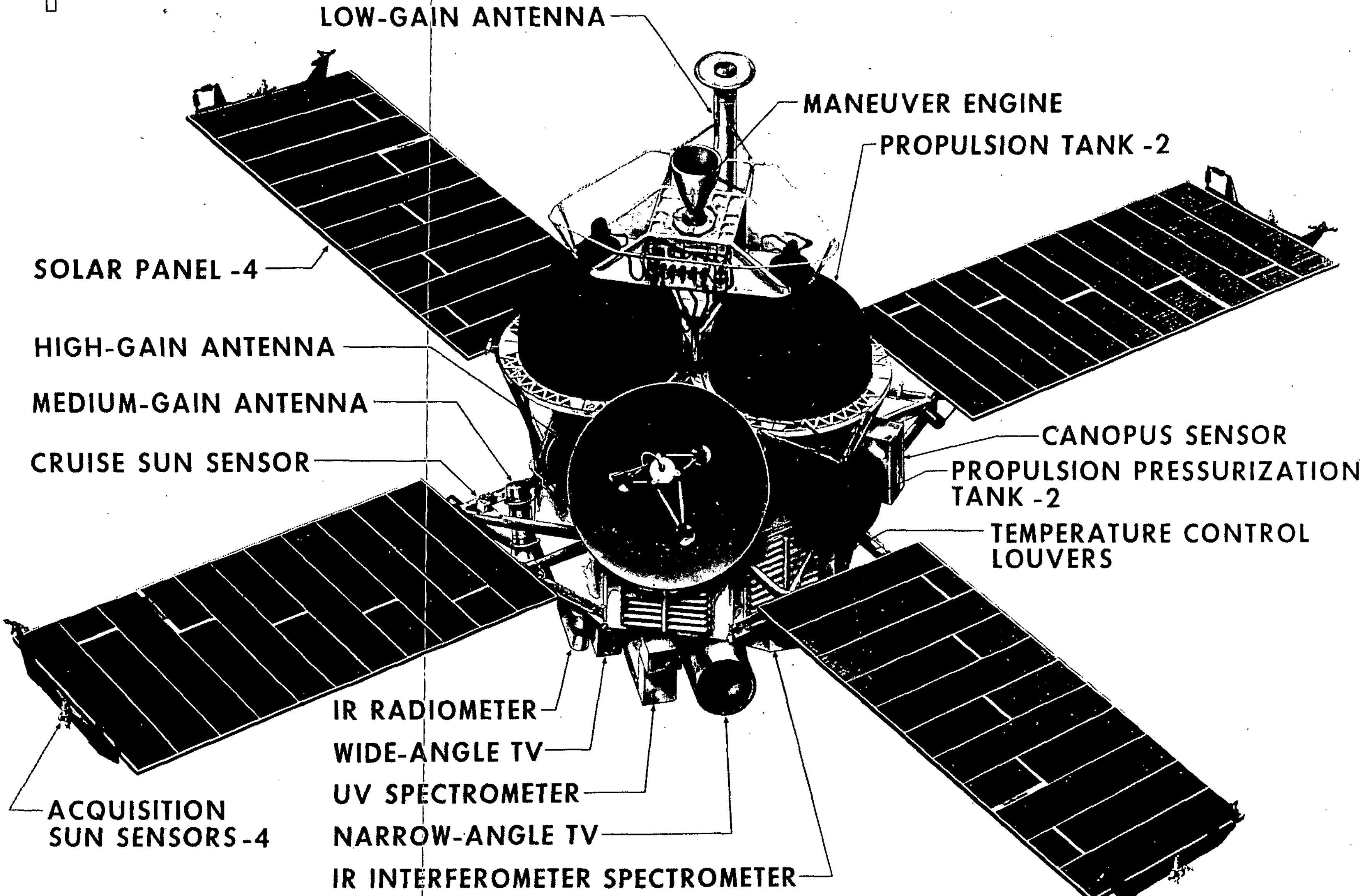
The Mariners will carry science instrumentation for four planetary experiments. Two additional experiments--spacecraft occultation by Mars and celestial mechanics--require only the spacecraft communications system as the source of their data.

Two television cameras, an infrared interferometer spectrometer (IRIS), ultraviolet spectrometer (UVS) and infrared radiometer (IRR) are mounted on a motor-driven two-degree-of-freedom scan platform on the bottom or shaded side of the octagon. Total rotating weight of the platform mechanism and its science instrument payload is 181 pounds (82.2 kilograms).

Each Mariner weighs 1,200 pounds (544 kilograms) unfueled and measures 7 1/2 feet (2.29 meters) from the scan platform to the top of the low-gain antenna and rocket nozzle. With solar panels deployed, the spacecraft spans 22 feet, 7 1/2 inches (4.35 meters). The octagonal structure measures 54 1/2 inches (1.39 meters) diagonally and 18 inches (0.457 meters) in depth.

Launch weight, including 1,000 pounds (454 kilograms) of rocket fuel and oxidizer, is more than 2,200 pounds (1,000 kilograms).

MARINER MARS 1971 SPACECRAFT
TOP VIEW



NOTE: PROPULSION MODULE AND SCAN PLATFORM INSULATION BLANKETS NOT SHOWN

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Data Automation Subsystem

The five science instruments on the spacecraft are controlled and synchronized by the Data Automation Subsystem (DAS) and data from the instruments are converted by the DAS into digital form for transmittal to Earth.

The experiments controlled by the DAS are television, infrared radiometer, infrared interferometer spectrometer and ultraviolet spectrometer. The S-band occultation experiment and the celestial mechanics experiment do not require special equipment aboard the spacecraft and are not controlled by the DAS.

The DAS controls instrument sequencing, accumulates varied science data, reduces them to a common digital form and common rate and then feeds the data to the tape recorder or to the selected science telemetry channel at proper intervals for transmission to Earth.

Attitude Control

Stabilization of the spacecraft is provided by a system of 12 cold gas jets mounted at the outer ends of the four solar panels. The jets are linked by logic circuitry to three gyroscopes (one gyro for each of the spacecraft's three axes), to the Canopus sensor and Sun sensors.

The gas system is divided into two sets of six jets, each set complete with its own gas supply, regulators, lines and valves so that a leak or valve failure will not deplete the gas and jeopardize the mission. Each system is fed by a titanium bottle containing nitrogen gas pressurized at 2,500 pounds-per-square-inch (175.7 kilograms-per-square-centimeter). Normally, both sets will operate during the mission. Either system can support the entire flight in the event of a failure in the other.

The Sun sensors are light-sensitive diodes which inform the attitude control system when they see the Sun. The attitude control system responds to these signals by turning the spacecraft and pointing the solar panels toward the Sun for stabilization on two axes and for conversion of solar energy to spacecraft power. Nitrogen gas escapes through the appropriate jet nozzle, imparting a reaction to the spacecraft to correct its angular position.

The star Canopus, one of the brightest in the galaxy, will provide a second celestial reference upon which to base maneuvers, point the high gain antenna toward Earth and the instruments toward Mars. The Canopus sensor will activate the gas jets to roll the spacecraft about the already-fixed longitudinal or roll axis until it is locked in cruise position. Canopus acquisition occurs when the light intensity in the field of view of the sensor matches the intensity anticipated for the star Canopus. Brightness of the sensor's target star will be telemetered to the ground to verify the correct star has been acquired.

Periodically during the flight, the Canopus sensor will be updated to compensate for the changing angular relationship between the spacecraft and the star. The sensor's field of view or "look angle" will be changed electronically to follow Canopus throughout the mission.

Upon receipt of commands from the Central Computer and Sequencer (CC&S), the attitude control system orients the spacecraft to align the thrust axis of the rocket engine in the direction required for the trajectory correction maneuver.

During firing of the engine, stabilization of the spacecraft will be effected by gimballing the engine so that thrust direction remains through the spacecraft's center of gravity. The Mariner's autopilot controls spacecraft attitude during engine firing by using the gyros to sense motion about the spacecraft's three axes for gimballing the engine.

Propulsion

Mariner's rocket engine provides small trajectory corrections to the spacecraft during Earth-to-Mars transit, deceleration into Mars orbit and trim maneuvers to achieve the desired periapsis and orbital period. The engine, capable of at least five starts and shutdowns, provides a continuous thrust of 300 pounds (0.36 kilograms).

The rocket nozzle protrudes from the top of the spacecraft along its longitudinal or roll axis.

The fuel, monomethyl hydrazine, and the oxidizer, nitrogen tetroxide, are contained in two 30-inch (0.762 meters) diameter pressure vessels. The propellants are forced into the engine's combustion chamber by nitrogen gas compressing bladders in the spherical tanks. Hypergolic ignition of the fuel and oxidizer causes rapid expansion of hot gases in the engine.

Firing of the engine is controlled by the CC&S, which receives the time, direction and duration of required thrust through the ground-to-spacecraft communication link. At the command signal from the CC&S, solenoid-actuated engine valves allow the propellants to enter the thrust chamber from the already pressurized tanks. For termination of thrust, an accelerometer activates the solenoid, stopping propellant flow.

During engine firing, spacecraft attitude is maintained by autopilot-controlled gimballing of the engine.

Both Mariners may perform two midcourse maneuvers -- the first about six days after launch and the second as late as 10 days prior to encounter with Mars.

Insertion into orbit around Mars will be achieved with a long -- 14-minute -- engine burn to decelerate the spacecraft. Spacecraft velocity will be decreased by about 3,250 miles per hour (1,450 meters per second).

Each spacecraft will execute one or two trim maneuvers while in orbit around Mars. Additional trim maneuvers are possible.

Each Mariner will carry more than 1,000 pounds (454 kilograms) of propellants, about 45 per cent of the total spacecraft launch weight.

Central Computer and Sequencer

Mariner is designed to operate throughout its basic mission without the need of ground commands --with the exception of spacecraft maneuvers. This automatic capability is made possible by the on-board command function of the Central Computer and Sequencer (CC&S). Critical events, however, are backed up by the ground command capability.

The CC&S performs the timing, sequencing and computations for other subsystems aboard the spacecraft. It initiates spacecraft events in six mission sequences--launch, cruise, midcourse maneuver, orbit insertion maneuver, orbit trim maneuvers and orbital science.

Timing and sequencing are programmed into the CC&S prior to launch but can be modified anytime during the flight by command from the ground.

The CC&S consists of a special purpose programmable computer and a fixed sequencer for redundancy during maneuvers.

Under normal circumstances, the programmable computer portion and the fixed sequencer portion of the CC&S operate in tandem for the midcourse maneuver and orbit trim maneuvers. If there is disagreement on any maneuver event the maneuver is aborted and the spacecraft returns to the cruise condition. A maneuver also can be performed by either portion of the CC&S alone.

The fixed sequencer will be prime for the maneuver that puts Mariner into orbit around Mars. Selected backup functions will be provided by the programmable computer.

Communications

Two-way communications with the Mariners will be by radio link between Earth tracking stations and a dual transmitter-single receiver radio system aboard each spacecraft.

The on-board communications system also includes a telemetry subsystem, command subsystem, data storage subsystem and high-gain, low-gain and medium-gain antennas.

The spacecraft S-band receiver will operate continuously during the mission at about 2,210 megahertz. (The receivers in the two Mariners will operate at slightly different frequencies. Similarly, no two transmitters will operate at exactly the same frequency.) The receiver will be used with the high-gain antenna only or a combination of the low-gain omnidirectional antenna and the medium-gain antenna. The spacecraft receives uplink command and ranging signals from ground stations of the Deep Space Network

To provide the standard doppler tracking data, the radio signal transmitted from Earth is received at the spacecraft, changed in frequency by a known ratio and re-transmitted to Earth. In addition, a JPL-developed ranging technique using an automatic coded signal provides range measurements with an accuracy of a few yards at the Mars-Earth distance. The ranging function may be commanded on and off by ground command, or off by the Central Computer and Sequencer.

When no uplink signal is being received by Mariner, the transmitted frequency of about 2,295 megahertz originates in the spacecraft transmitter. The transmitter consists of two redundant exciters and two redundant radio frequency power amplifiers of which any combination is possible. Only one exciter-amplifier combination will operate at any one time. Selection of the combination will be by on-board failure detection logic with ground command backup.

Both amplifiers on each spacecraft employ traveling wave tubes and are capable of operating at 10 watts or 20 watts output and the signal may be transmitted through either the high-gain or low-gain antenna. Transmission via the high-gain antenna will be required during the encounter and playback phases of the mission.

The high-gain antenna, with a 40-inch-diameter (1.02 meters) parabolic reflector, provides a highly directional beam for the downlink radio signal. The high-gain antenna has two positions with respect to the spacecraft. It is deployed to the second position during orbit to enhance communications during the orbital phase. The low-gain antenna provides essentially uniform coverage in the direction of Earth. The medium-gain antenna, coupled to the low-gain is used to provide telemetry to Earth during the maneuver into Mars orbit.

All communications between the Mariners and Earth will be in digital form. Command signals transmitted to the spacecraft will be decoded--translated from a binary form into electrical impulses--in the command subsystem and routed to their proper destination.

Three types of commands are transmitted to the spacecraft: a direct command (DC) results in the closure of a switch in one of the spacecraft subsystems; a coded command (CC) provides information to the Central Computer and Sequencer for maneuvers or to update the CC&S program; a quantitative command (QC) is used to position the scan platform. A coded command to the Data Automation System allows selection of TV camera filters, shutter speeds and other science instrument options. There are 82 possible DC's which back up all critical automatic spacecraft functions, choose redundant elements, initiate maneuvers and perform other functions.

Data telemetered from the spacecraft will consist of engineering and science measurements prepared for transmission by the Telemetry Subsystem, the Data Automation Subsystem (real-time TV and science) and Data Storage Subsystem (recorded science including TV). The encoded information will indicate voltages, pressures, temperatures and other values measured by the spacecraft telemetry sensors and science instruments.

There are three data channels: the engineering channel which operates throughout the flight; the low-rate science channel employed during the orbital phase of the mission; and the high-rate science channel.

Mariner can transmit information to Earth at eight different rates: on the engineering channel at 8 1/3 bits per second and 33 1/3 bps; on the science channel at 50 bps; and on the high-rate science channel at 16,200 bps and 8,100 bps. Data storage playback rates are 16,200 bps, 8,100 bps, 4,050 bps, 2,025 bps and 1,012.5 bps.

Certain conditions must exist in order to utilize the high-rate channel. These include the availability of the 210-foot (64-meter) diameter antenna at the Goldstone Complex of the Deep Space Network (DSN) for receiving. The DSN's 85-foot (26-meter) antennas can receive data at rates up to 2,025 bps.

Approximately 90 engineering measurements are obtained by transducers throughout the spacecraft to make up the engineering data. The engineering samples are taken continuously and can be transmitted along with science regardless of the science channel or rate in use.

The Data Storage Subsystem (tape recorder) records digital science data from the Data Automation System during the orbital phase at 132,300 bits per second until the eight tape tracks are filled. Data consists of digitized video from the TV cameras and the other science instruments. Total storage capacity for each spacecraft is 180 million bits.

Playback is initiated by either on-board or ground command. One of the five playback data rates -- from 1,012.5 bits per second to 16,200 bps -- is selected depending upon the availability of the 210-foot (64-meter) Goldstone antenna and the Earth-Mars distance.

Power

The Mariner power subsystem supplies electrical power to the spacecraft, switches and controls the power and provides an accurate timing source for the spacecraft.

Primary power source is an arrangement of 17,472 photovoltaic solar cells mounted on four panels which will face the Sun during most of the flight to Mars and during orbital operations. The cells, covering 83 square feet (7.8 square meters), will collect solar energy and convert it into electrical power.

A rechargeable nickel-cadmium battery provides spacecraft power during launch and whenever the panels are turned away from the Sun. The battery will be kept in a state of full charge and will be available as an emergency power backup source.

Two power regulators will provide redundancy. In the event of a failure in one, it will be removed automatically from the line and the second will be switched in to assume the full load.

The solar panels will be folded in a near vertical position above the body of the spacecraft during launch and will be deployed after separation from the launch vehicle. Each panel carries 4,368 solar cells (2 x 2 cm.) and protective glass filters that reduce the amount of solar radiation absorbed without interfering with the energy conversion. The cell modules are supported by lightweight panel structures made of thin-gauge aluminum.

Nominal power capability of the panels is expected to be 800 watts at maximum power voltage for cruise conditions in space near Earth. This power capability decreases to about 500 watts at the Mars distance if there is no degradation because of solar flares. Maximum power demand is expected to be less than 400 watts during orbital operations.

Minimum capacity of the spacecraft battery is 600 watt hours. The battery will be capable of delivering its required capacity and meeting all electrical requirements within an operational temperature range of 30 to 90 degrees Fahrenheit (10 to 32 degrees Celsius). At temperatures outside this range, it will still function although its capability will be reduced.

To ensure maximum reliability, the power subsystem was designed to limit the need for battery power after initial Sun acquisition. Except during maneuvers, the battery will remain idle and fully charged. The battery charger will provide a high-rate or a trickle charge.

Under normal flight conditions, the primary power booster-regulator will handle all spacecraft loads. A second regulator will support power loads on a stand-by basis. Should an out-of-tolerance voltage condition exist in the main regulator, the stand-by regulator will take its place on the line.

Primary form of power distributed to other spacecraft systems is 2,400 hertz square wave. The gyro spin motors use 400 hertz three-phase current, and the scan motor is supplied with 400 hertz single-phase current. The transmitter amplifier tube, battery chargers and temperature control heaters use unregulated dc power from the solar panels or the battery.

A crystal oscillator in the main power inverter controls the frequency to within 0.01 per cent, assuring other spacecraft systems of a reliable, accurate frequency on their power line. A backup crystal oscillator is located in the stand-by inverter. The spacecraft Central Computer and Sequencer uses the oscillator frequency as a timing source.

Telemetry measurements have been selected to provide the necessary information for the management of spacecraft power loads by ground command if necessary.

The battery, regulators and power distribution equipment are housed in two adjacent electronics compartments on Mariner's octagonal base.

Temperature Control

For a spacecraft traveling to Mars, away from Earth and from the Sun, the primary temperature control problem is maintaining temperatures within allowable limits despite the decreasing solar intensity as the mission progresses. In airless space, the temperature differential between the sunlit side and the shaded side of an object can be several hundred degrees.

Heating by direct sunlight on the Mariner spacecraft is minimized by the use of a thermal blanket on its Sun side. The side away from the Sun is covered with a thermal blanket to prevent rapid loss of heat to the cold of space.

The top of Mariner's basic octagon and the propulsion module are insulated from the Sun by a multi-layered shield of aluminized Teflon. The outer layer of the shield, constructed of a tightly-woven fiberglass cloth, also serves as a foil against micrometeoroids. The bottom is enclosed by another multi-layered blanket to retain heat generated by power consumption within the spacecraft.

Temperature control of six of the electronics compartments is provided by polished metal louvers actuated by coiled bimetallic strips. The strips act as spiral-wound springs that expand and contract as they heat and cool. This mechanical action, which opens and closes the louvers, is calibrated to provide an operating range from fully closed at 55 degrees Fahrenheit (13 degrees Celsius) to fully open at 90 degrees Fahrenheit (32 degrees Celsius). A louver assembly consists of 22 horizontal louvers driven in pairs by 11 actuators. Each pair operates independently on its own local temperature determined by internal power dissipation.

The science platform and its array of instruments at the bottom of the octagon are covered by a third thermal blanket. The platform is designed to be thermally isolated from the main equipment octagon by a plastic collar on the attaching support tube. Temperature control is achieved by electrical dissipation in heaters and in the instruments themselves.

Electric heaters are located within the science platform blanket, in the propulsion module and in two of the electronics bays to provide additional heat during certain portions of the mission.

Paint patterns and polished metal surfaces are used on the Mariner for passive control of temperatures outside of the protected octagon and covered science platform. These surfaces control both the amount of heat dissipated into space and the amount of solar heat absorbed or reflected away. The patterns were determined from testing a Temperature Control Model (TCM) of the spacecraft in a space simulation chamber at JPL and from the application of actual mission data acquired during the Mariner 4 (1964-65) and the Mariner 6 and 7 (1969) missions to Mars.

The high-gain antenna dish, which is dependent upon the Sun for its surface heat, is painted green to keep it at near room temperature at the Mars distance but within its upper thermal limit earlier in the mission.

Scan Platform

Mariner's science instruments are mounted on a scan platform which can be rotated about two axes to point the instruments toward Mars during the spacecraft's approach to the planet and while in orbit. The platform is located below the octagonal base of the spacecraft.

The scan control system allows multiple pointing directions of the instruments as the orbit phase of the mission progresses. The platform's two axes of rotation are described as the clock angle motion about the axis of the tube extending vertically from the octagon and cone angle motion about an axis which is horizontal.

The platform is motor-driven and moves 215 degrees in clock and 69 degrees in cone.

The scan pointing positions are programmed in flight and during the orbital sequence by commands from the Central Computer and Sequencer or radio commands from Earth.

As Mariner approaches Mars -- several days prior to going into orbit around the planet -- the narrow-angle TV camera will take a series of spaced "picture pairs" of the full disc of Mars. The pre-orbit TV sequence, enabled by a command from the CC&S begins when the planet is sufficiently bright and within the field-of-view of the camera.

During the orbital phase of the mission, scan platform pointing can be updated each orbit by ground command as scientists evaluate data from previous orbits.

SCIENTIFIC EXPERIMENTS

Mars is a constantly changing world with seasonal and daily variations that have been observed with difficulty from Earth and only briefly by flyby spacecraft.

In this orbiting mission a battery of instruments will probe the planet on a daily basis for three months and possibly longer.

The surface will be examined by photography and in the infrared wavelengths. The atmosphere will be examined in the ultraviolet and infrared and by the occultation experiment.

From the top of the thin Martian gas envelope down to the surface and the interior of craters, the atmospheric instruments will record data to identify gases, plot the mixture of constituents and variations relative to time and area.

The instruments will view an early winter atmosphere and surface in the North and early summer in the South.

The information gathered should provide a broad picture of the factors that shape physical processes at work on Mars. The questions to be answered range from daily weather patterns to the history of the formation of the planet.

The cutting edge of this mission is not only the opportunity to examine Mars in detail on a daily basis but is also the carefully planned correlation of data from the instruments to yield more than the sum total of the parts.

For example, the ultraviolet experiment and the two infrared experiments are boresighted with the two TV cameras. The ultraviolet spectrometer in probing the atmosphere, provides an elevation profile of the surface under the UV scan path. This in turn, can be correlated with photographs and with occultation pressure data as was the case in the 1969 flight in the vicinity of the feature Hellas and the adjacent area of Hellespontus.

A photograph can be correlated with temperatures on the surface and the pressure and constituents of the atmosphere above the area photographed. A physical feature on the surface can thus be related to other data obtained.

Past observations have established the presence of clouds, hazes, bright spots and flares of light on the surface. Yellow clouds, thought to be dust, can grow large enough to obscure a large portion of the face of Mars and last a month or two. White clouds range from a haze, lasting a few hours, to huge dense clouds persisting for days or weeks. Dark gray clouds have been reported and thought to possibly be volcanic in origin. Four were reported in 1950 and 1952. Flares seen on the surface have also been attributed to possible volcanic activity.

Study of these phenomena by the combined instrument package is an objective of the mission.

Another specific scientific objective is a study of the "wave of darkening". Observations from Earth have established that there is a seasonal darkening of features on Mars but if it progresses at a regular rate in a waveform is, today, open to question.

The spacecraft will arrive at Mars at the peak of the darkening period in the southern hemisphere. It will be observed at its maximum intensity and can be compared with observations in the northern hemisphere.

The water content of the Martian atmosphere is known to be extremely low, similiar to the dry Antarctic. But it is possible that free water was frozen in the past and remains under the surface like permafrost. Heat escaping from the interior of Mars could melt the ice and provide a water source for organisms. If so, such an area would be a prime target for the Viking lander that will seek evidence of life on Mars in 1976.

In the low pressure of the Martian atmosphere, however, water can only exist in a frozen or vaporous state with perhaps a short-lived intermediate state that could moisten the soil. In the event of underground ice melting there is, then, a possibility of a cloud forming over the area. Photography of such a cloud correlated with water vapor and temperature measurements could indicate an area acceptable for life forms.

The mapping of Mars in this mission is a basic objective. It is essential in the study of a planet to establish a three dimensional shape of the planet, the figure. A persistent discrepancy, however, exists between optical observations from Earth and data derived from the orbits of the two moons of Mars and spacecraft flyby trajectories.

Studies of the '71 data may resolve that question and will establish the Martian geoid, a standard spherical reference surface for mapping. On Earth, the geoid coincides with mean sea level in the oceans.

Discrepancies of five to 10 degrees in latitude and longitude , 180 to 380 miles (290 to 610 kilometers) at the surface, are not uncommon between various published maps of Mars. A recently completed 10-year Mars Map Project, by de Vaucouleurs, using all Earth-based visual and photographic data from 1877 to 1958 may have reduced errors to about one degree, or 31 miles (50 kilometers) in regions where well-defined surface markings (i.e., albedo variations) are available. One of the major mapping applications of the wide-angle camera photography will be to precisely locate surface markings to a resolution of approximately one mile (1.6 kilometers).

Television

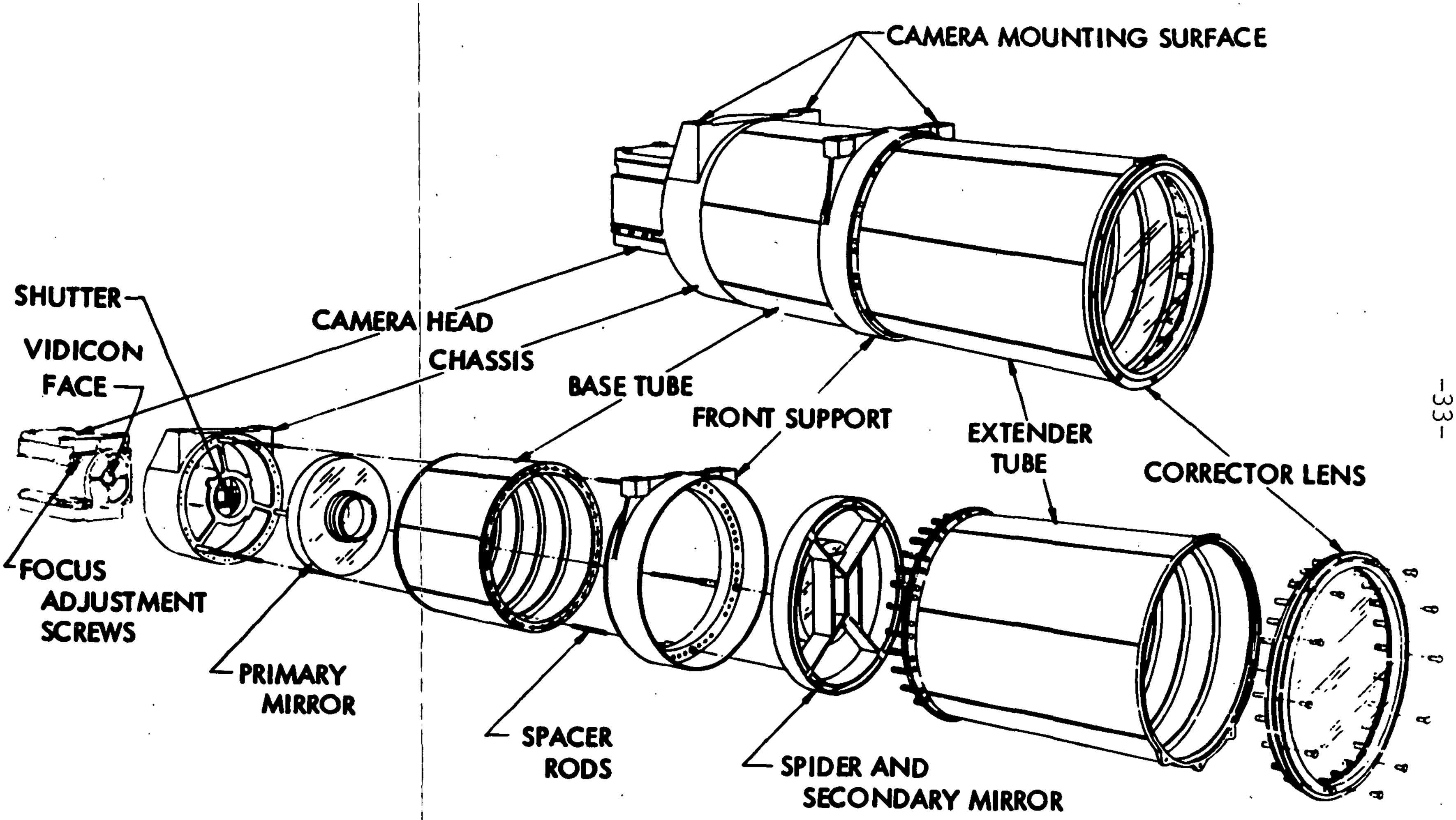
The television experiment will provide for Mission A, a map of 70 per cent of Mars at medium resolution and detailed studies of 5 per cent of the surface at high resolution. Mariner 4 in 1965 photographed 1 per cent of the surface, and Mariners 6 and 7 in 1969,10 per cent.

The wide-angle cameras will resolve features on the surface about 3,280 feet (1,000 meters) in length. Narrow-angle cameras will resolve features about 328 feet (100 meters) in length.

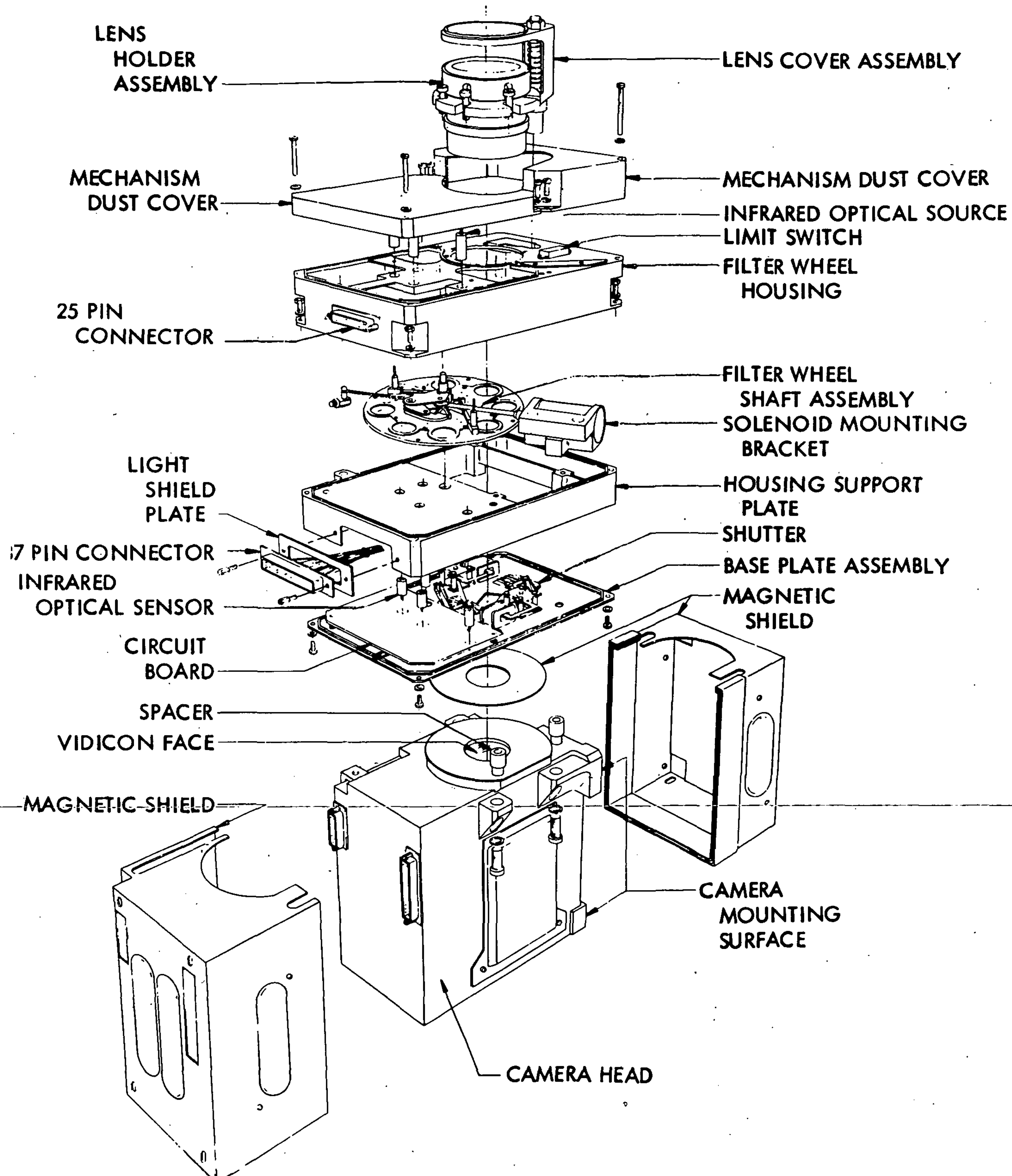
The advantages of an orbiting mission will be exploited for Mission B in repeated photographic studies of individual areas over a period of time to detect changes on the surface and in the atmosphere.

Specific areas of study are the "wave of darkening" (seasonal surface color change), polar caps and the polar cap-edge, atmospheric and surface fluorescence, atmospheric haze, blue clearings, white and yellow clouds and cloud movements.

MARINER NARROW ANGLE TV CAMERA



MARINER WIDE ANGLE TV CAMERA



Although not a primary objective, the two moons of Mars, Phobos and Diemos, may be photographed to obtain information on their shape , size and surface features. Prelaunch studies indicate that the spacecrafts will come within sufficient proximity of the moons to obtain surface data.

Detection of any life forms on Mars is beyond the resolution capabilities of the cameras. However, correlation of the photographs with other data may yield information on the possibility of life forms on Mars or on suitability of Mars as a habitat for life.

Prior to insertion into orbit, the narrow cameras will provide approach photographs of Mars similar to the series taken in 1969 by Mariners 6 and 7. The sequences will begin at ranges in excess of one million miles (1,609,000 kilometers) from Mars.

As the '71 flights will arrive at Mars in a different season than the '69 flights, the approach pictures will provide project scientists with valuable data for planning the orbital operations and scientific data on changes that have occurred since 1969.

It will be early winter in Mars' northern hemisphere on arrival and early summer in the southern hemisphere. This is similar to telescope observations made in 1958 at Mars opposition.

The TV experiment on Mariner H (Mission A) will, in mapping the surface, provide a wide range of information for studies of bright and dark regions, fine structure of topographic details, and such processes as volcanism, tectonism, impact, erosion and atmospheric activity.

The objectives also include:

- A determination of the shape of the planet. (Data from trajectories of flyby spacecraft and the orbits of the two Martian moons do not agree with Earth-based observation.

- High precision geodetic coordinates of a large number of well defined topographic features for maps of the planet.

- To investigate, by photometric and photogrammetric analysis, surface slopes and relative elevation characteristics; to determine surface brightness and albedo differences; and to perform analyses related to improving the accuracy of the photometric function of Mars.

It is evident from Earth-based radar data that albedo (amount and spectrum of reflected light) and elevation differences on Mars do not have a close correlation. Detailed studies of this fact may have great significance for an interpretation of observed albedo variations.

Mariner I (Mission B) will study time-variable features on the surface and in the atmosphere of Mars in order to obtain information on the atmospheric structure and circulation, details of diurnal and seasonal changes, and clues regarding the possibility of life on Mars. The specific areas to be studied are wave of darkening, polar caps and cap adjacent areas, nightside atmospheric and surface fluorescence, haze in the atmosphere, white clouds and patches at low latitudes, yellow clouds and storms and the Martian satellites to obtain information on their shape and surface features.

Each wide-angle camera is equipped with commandable filters allowing a choice of eight filters.

The team leader is Harold Mazursky, U. S. Geological Survey, Flagstaff, AZ. Other principal investigators are Bradford Smith, New Mexico State University; Dr. Joshua Lederberg, Stanford University; Dr. Gerard de Vaucouleurs, University of Texas; and Dr. Geoffrey A. Briggs, Bellcom.

Infrared Radiometer (IRR)

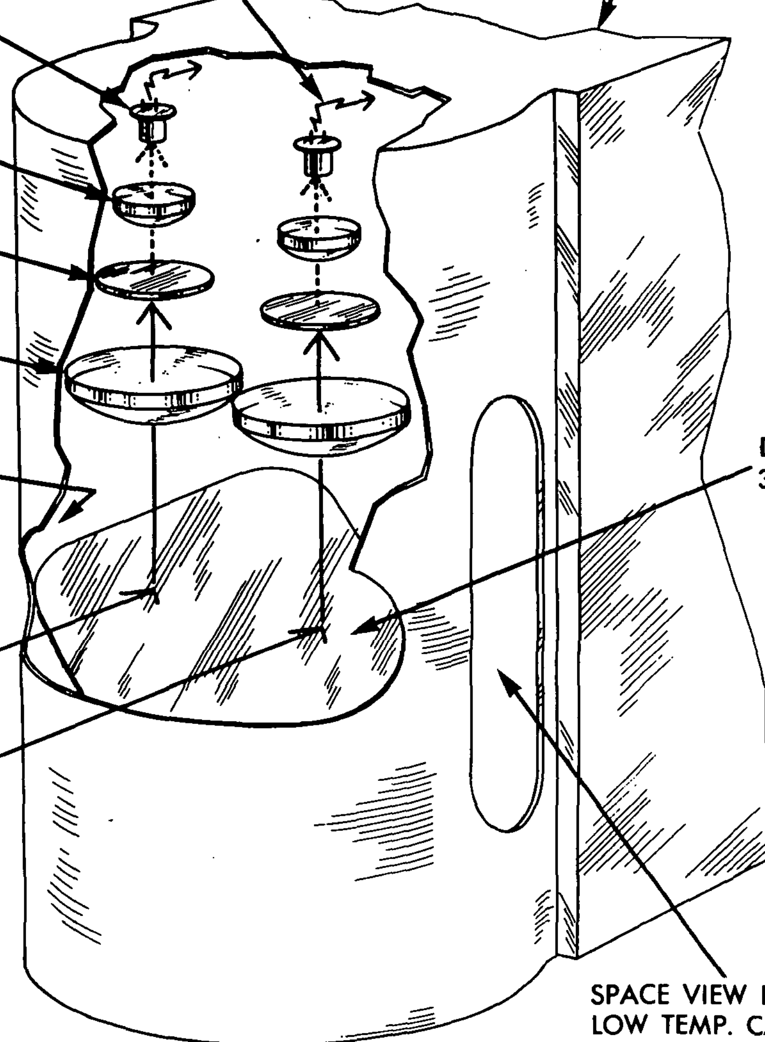
This experiment will provide temperature measurements of the surface of Mars by detection of thermal radiation in the infrared portion of the electromagnetic spectrum.

The instrument is boresighted with the television cameras to allow correlation of surface temperatures with terrain features and clouds.

The thermophysical properties of the surface will be mapped during the length of the standard missions. Irregularities in diurnal cooling curves will be compared to photographs for similarity of areas to visible albedo variation. Existence of "hot spots", which are slightly high average temperature areas, will be studied for indications of internal heat sources.

MARINER INFRARED RADIOMETER

(TO MEASURE MARS SURFACE TEMPERATURES)



The infrared radiometers on each Mariner '69 mission measured temperatures over broad areas of the planetary surface on a single sweeping pass. The temperatures, therefore, as a function of local time, could only be established in a mean sense.

Observations from Mariner '71 will provide cooling curves characteristic of individual areas; thus, the degree of correlation that may exist between characteristic cooling curves and major physiographic features can be found.

Essentially the same instrument flown on this mission was flown on the 1969 mission to Mars but viewed only one per cent of the surface. In the orbiting mission it is expected that as much as 20 per cent of the surface will be covered.

The wider coverage is expected to determine accurately the thermophysical properties of surface features.

The principal investigator is Dr. Gerry Neugebauer of the California Institute of Technology.

Ultraviolet Spectrometer

The objectives of this experiment are to map the surface and lower atmosphere in ultraviolet (ultraviolet cartography) and to study the temperature and structure in the upper atmosphere (ultraviolet aeronomy).

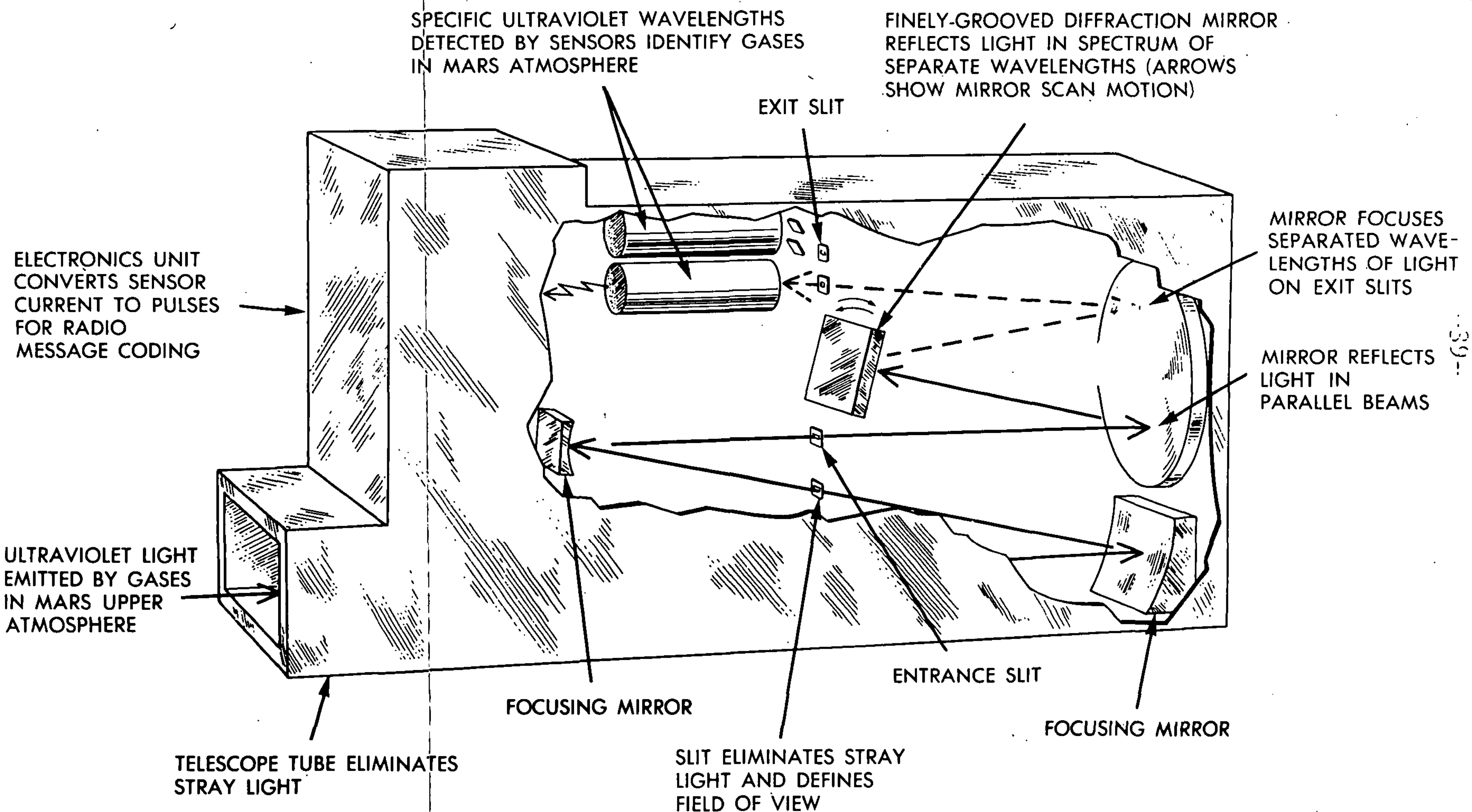
The experiment will measure: local atmospheric pressures which can be related to elevations over a major part of Mars; local concentrations of ozone; reflectability of the Martian surface in the near-ultraviolet and provide UV studies of the "wave of darkening" clouds and the blue haze-blue clearing.

Detection of ozone could yield clues as to the possibility of life forms on Mars. Biological activities can produce molecular oxygen which can lead to the formation of ozone. If the measurement of ozone is at high enough levels, then the possibility exists that life may be present. This level would have to exceed what could be explained by other non-biological processes. Final determination of the life question, however, will depend on a landed system with measurements taken at the surface.

- more -

MARINER ULTRAVIOLET SPECTROMETER

(TO IDENTIFY GASES IN UPPER ATMOSPHERE OF MARS)



The UV experiment will also yield data on atmospheric density, temperatures relative to altitude in the upper atmosphere and the amount of UV which strikes the surface of Mars. UV is deadly to life forms. The amount reaching the surface of Mars could have a bearing on the question of life on Mars, although shielding against UV would be relatively simple. The variation of atmospheric constituents with season will be also detectable as the mission progresses.

Principal investigator for this experiment is Dr. Charles Barth of the University of Colorado.

Infrared Interferometer Spectrometer (IRIS)

This experiment will measure radiation in infrared wavelengths from the surface and atmosphere of Mars to provide information on a wide range of physical characteristics of Mars.

In general, the data will provide a picture of the circulation of the atmosphere and composition of the surface.

In detail the experiment is expected to yield constituents of the atmosphere, including the important measurement of the amount of water vapor; temperatures and pressures at the surface, temperature profile of the atmosphere, materials on the surface, and determination of the composition of the polar caps, frozen carbon dioxide, frozen water or a mixture of both.

Although atmospheric and surface data will provide a basis for biological inferences, the question of life on Mars will only be resolved when a landed system can take measurements at the surface.

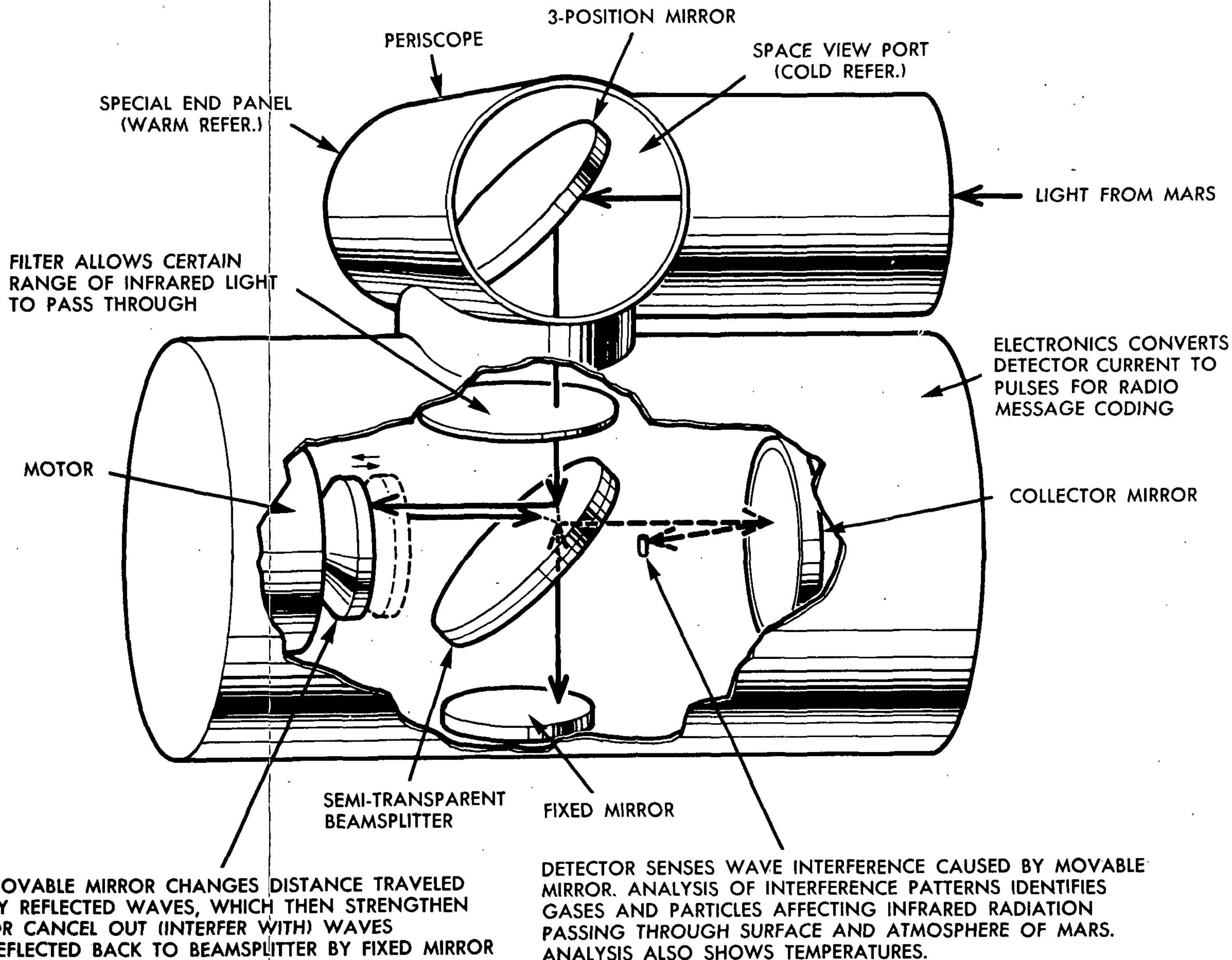
The principal investigator is Dr. Rudolph Hanel, Goddard Space Flight Center.

S-Band Occultation Experiment

This experiment has been successfully performed by flyby spacecraft at Venus in 1967 and at Mars in 1965 and 1969. The two latter missions yielded three pairs of occultation measurements. The '71 orbiting mission will provide up to 100 pairs from the two spacecraft in the 90-day missions. A pair includes measurements when the spacecraft disappears behind the planet and reappears.

MARINER INFRARED INTERFEROMETER SPECTROMETER

(TO MEASURE GASES, PARTICLES, TEMPERATURES ON AND ABOVE MARS SURFACE)



The occultation experiment on the '71 mission will provide multiple measurements of the radius of Mars, atmospheric pressures, and vertical structure, electron density profile of the ionosphere and surface characteristics and radius measurements.

This experiment utilizes the radio signals transmitted from the spacecraft to Earth and does not require on-board equipment. It does require an orbital path that passes behind Mars as seen from Earth, thus occulting the spacecraft from the view of tracking stations.

As the spacecraft curves behind Mars, its radio signal will pass through the Martian atmosphere and be cut off at the surface. The signal will reappear as the spacecraft comes out from behind the planet and again the radio signal will pass through the planet's atmosphere.

The atmosphere will refract the radio waves, changing them in frequency and strength. Measurements on Earth of these changes in the radio signal yield the data on the density and pressure of the atmosphere.

Similar changes in the atmosphere of Mars are caused by electron density and are also measureable.

The cutting off of the signal at the surface and resumption of the signal as the spacecraft comes out from behind the planet Mars, provides data for calculation of the radius and shape of Mars.

Determination of the atmospheric density of Mars is vital to the design of future landing craft, and is a critical factor in the resolution of important scientific questions on the nature of the planet.

The principal investigator is Dr. Arvydas Kliore of JPL.

Celestial Mechanics

Radio tracking of two orbiting spacecraft over a period of time is expected to provide a more accurate description of the Martian gravity field than provided by the orbits of the two moons of Mars and refinement of the astronomical unit (the distance from the Sun to Earth, a basic astronomical yard stick) to a fraction of a mile. This accuracy of the expected AU refinement is unprecedented.

This experiment derives its results from spacecraft tracking information and does not require special hardware on the spacecraft.

The objectives of the experiment includes measurements of the mass of Mars; the Earth-Moon mass ratio and the distance from Earth to Mars. Long-range objectives are to obtain an improved ephemeris of Mars (its position at given times in its solar orbit) to a high order of accuracy and to attempt to measure General Relativistic effects on orbital motions and signal propagation.

Improving the ephemeris of Mars is part of an existing NASA/JPL project to improve the ephemerides of all the inner planets. The Mariner tracking data will be combined with radar and optical telescope data to achieve the results.

The team leader is Dr. J. Lorell of JPL. The other principal investigator is Dr. Irwin I. Shapiro of the Massachusetts Institute of Technology.

MARINER MARS 1971 SCIENCE EXPERIMENTS AND INVESTIGATORS

Television

Harold Masursky-Team Leader	U.S. Geological Survey	Principal Investigator
Bradford Smith-Deputy	New Mexico State University	"
Dr. Joshua Lederberg	Stanford University	"
Dr. Gerard de Vaucouleurs	University of Texas	"
Dr. Geoffrey A. Briggs	Bellcom	"
David W. Arthur	U.S. Geological Survey	Co-Investigator
Raymond Batson	"	"
Warren Borgeson	"	"
Dr. Michael Carr	"	"
Dr. John F. McCauley	"	"
Dr. Daniel Milton	"	"
Dr. Lawrence A. Soderblom	"	"
Dr. Robert Wildey	"	"
Dr. Don Wilhelms	"	"
Dr. Elliot Levinthal	Stanford University	"
Dr. James B. Pollack	Ames Research Center	"
Dr. Carl Sagan	Cornell University	"
Dr. Andrew T. Young	Jet Propulsion Laboratory	"
Paul L. Chandeysson	Bellcom	"
Earl Shipley	"	"
Dr. James A. Cutts	California Institute of Technology	"

- more -

Television (cont'd)

Merton Davies	Rand Corporation	Co-Investigator
Dr. William Hartmann	Illinois Institute of Technology, Research Institute, Tucson	"
Dr. Robert Leighton	California Institute of Technology	"
Dr. Conway B. Leovy	University of Washington	"
Dr. Bruce C. Murray	California Institute of Technology	"
Dr. Robert P. Sharp	"	

Infrared Interferometer Spectrometer

Dr. Rudolph A. Hanel	Goddard Space Flight Center	Principal Investigator
Dr. Barney J. Conrath	"	Co-Investigator
Dr. W. A. Hovis	"	"
Virgil Kunde	"	"
Dr. Gilbert V. Levin	"	"
Dr. P. D. Lowman	"	"
Dr. Cuddapah Prabhakara	"	"
Benjamin Schlachman	"	"

Infrared Radiometer

Dr. Gerry Neugebauer	California Institute of Technology	Principal Investigator
Stillman Chase	Santa Barbara Research Center	Co-Investigator
Dr. Hugh K. Kieffer	University of California at Los Angeles	"

- more -

Infrared Radiometer (cont'd)

Dr. Ellis D. Miner	Jet Propulsion Laboratory	Co-Investigator
Dr. Guido Munch	California Institute of Technology	"

Ultraviolet Spectrometer

Dr. Charles A. Barth	University of Colorado	Principal Investigator
Dr. Charles W. Hord	"	Co-Investigator
Jeffrey B. Pearce	"	"

Celestial Mechanics

Jack Lorell-Team Leader	Jet Propulsion Laboratory	Principal Investigator
Dr. John D. Anderson	"	Co-Investigator
Warren L. Martin	"	"
Dr. Irwin I. Shapiro	Massachusetts Institute of Technology	Principal Investigator
Dr. Michael E. Ash	Lincoln Lab	Co-Investigator
William B. Smith	"	"

S-Band Occultation

Dr. Arvydas Kliore	Jet Propulsion Laboratory	Principal Investigator
Dan L. Cain	"	Co-Investigator
Dr. Gunner Fjeldbo	"	"
Dr. S. I. Rasool	Goddard Institute of Space Studies	"
Boris L. Seidel	Jet Propulsion Laboratory	"

- more -

ATLAS-CENTAUR LAUNCH VEHICLE

The launches of Mariners H and I mark the third and fourth times Atlas-Centaur launch vehicles have been used in the Mariner program. They were used to launch successfully Mariners 6 and 7 to Mars in 1969.

The AC-23 and AC-24 vehicles have been assigned to Mariner Mars '71.

Centaur, developed under the direction of the National Aeronautics and Space Administration's Lewis Research Center, was the first U.S. rocket to use the high-energy liquid hydrogen/liquid oxygen combination. Flown with an Atlas booster so far, Centaur is in the process of being integrated with the Titan III to launch Viking spacecraft to Mars in 1975.

The ability of the Atlas-Centaur to launch the much greater weight of the Mariner H and I spacecraft, approximately 2,200 pounds (998 kilograms) compared with the 850-pound (385-kilogram) weight of Mariners 6 and 7, is due primarily to the more favorable position of the planet Mars in relation to the Earth this year. Such a favorable alignment of the two planets will not occur again until the 1980's.

Some changes also have been made to the Centaur stages to increase their payload carrying capability. AC-23 and AC-24 will use a direct ascent, single burn trajectory to Mars. Because the Centaur engines will be ignited only once in space, it was possible to remove four three-pound thrust engines normally used to keep propellants settled in the tanks during coast periods. Baffles used to position propellants in a weightless environment have also been removed for this mission. Because of the single-burn mission, another small weight gain was realized by substituting a smaller helium tank. Helium is used to pressurize the propellant tanks during flight.

AC-23 and 24 consist of an Atlas SLV-3C booster combined with a Centaur second stage. The two stages are 10 feet (3.05 meters) in diameter and are connected with an interstage adapter. Both Atlas and Centaur stages rely on internal pressurization for structural integrity.

The Atlas booster develops 403,000 pounds of thrust at liftoff, using two 171,000-pound-thrust booster engines, one 60,000-pound-thrust sustainer engine and two vernier engines developing 690 pounds thrust each.

Centaur carries insulation panels and a nose fairing which are jettisoned after the vehicle leaves the Earth's atmosphere. The insulation panels, weighing about 1,200 pounds (544 kilograms), surround the second stage propellent tanks to prevent heat or air friction from causing excessive boil-off of liquid hydrogen during flight through the atmosphere. The nose fairing protects the payload.

To date Centaur has successfully launched the seven unmanned Surveyor spacecraft to the Moon, Mariners 6 and 7, and Orbiting Astronomical Observatory 2, Applications Technology Satellite 5 and the first Intelsat 4.

Launch Vehicle Characteristics

*Liftoff weight including spacecraft:	324,432 pounds (147,130 kilograms)
Liftoff height:	113 feet (34.4 meters)
Launch complexes:	36 A & B
Launch azimuth sector:	81 - 108 degrees

	SLV-3C Booster	Centaur Stage
**Weight:	283,577 lbs. (128,602 kg.)	37,657 lbs. (17,077 kg.)
Height:	75 feet (22.9 meters) (including interstage adapter)	48 feet (14.6 meters) (with payload fairing)
Thrust:	403,000 lbs. (sea level)	30,000 lbs. (vacuum)
Propellants:	Liquid oxygen and RP-1	Liquid hydrogen and liquid oxygen
Propulsion:	MA-5 system (two 171,000-lbs.-thrust engines, one 60,000-lb.-sustainer engine and two 690-lb.-thrust vernier engines)	Two 15,000-pound-thrust RL-10 engines. Ten small hydrogen peroxide thrusters.
Velocity:	5,766 mph (2,577 meters-per-second) at BECO 8,372 mph (3,742 m/s) at SECO	22,392 mph (10,010 m/s) at spacecraft separation
Guidance:	Pre-programmed pitch rates through BECO Switch to Centaur inertial guidance for sustainer phase.	Inertial guidance

* Measured at two inches (5.08 centimeters) of rise
**Weights are based on AC-23 configuration. AC-24 varies only slightly.

Atlas-Centaur Flight Sequence - AC-23*

Event	Nominal Time (Seconds)	Altitude Statute Miles	Altitude Kilometers	Surface Range Statute Miles	Surface Range Kilometers	Velocity MPH	Meters-per-second
Liftoff	0	0	0	0	0	0	
Booster Engine Cutoff	147.9	37.2	59.6	52.2	83.5	5,726.8	2,560
Booster Jettison	151.0	39.1	62.6	56.8	91.0	5,793.4	2,590
Jettison Insulation Panels	192.9	62.5	100.0	123.6	197.8	6,621.6	2,960
Jettison Nose Fairing	234.9	83.5	134.6	202.4	323.8	7,717.8	3,450
Sustainer Engine Cutoff	250.9	91.3	147.3	236.0	377.6	8,254.7	3,690
Atlas Separation	252.8	92.3	148.9	240.5	384.8	8,209.7	3,670
Centaur Engine Start	262.4	96.7	156.0	261.2	417.9	8,187.6	3,660
Centaur Engine Cutoff	716.0	109.5	176.6	1,951.1	3,121.8	24,540.3	10,970
Spacecraft Separation	811.0	116.4	187.7	2,581.1	4,129.8	24,540.3	10,970
Start Centaur Reorientation	1,271.0						
Start Centaur Retrothrust	1,366.0						

* Figures are for launch on May 17. There will be a slight variation for a launch on another day.

Atlas-Centaur Flight Sequence - AC-24*

Event	Nominal Time (Seconds)	Altitude Statute Miles	- Kilometers	Surface Range Statute Miles	- Kilometers	Velocity MPH	Meters-per-Second
Liftoff	0	0	0	0	0	0	
Booster Engine Cutoff	147.9	37.2	59.6	52.2	83.5	5,726.8	2,560
Booster Jettison	151	39.1	62.6	56.8	90.9	5,793.4	2,590
Jettison Insulation Panels	192.9	61.9	99.0	123.9	198.2	6,621.6	2,960
Jettison Nose Fairing	234.9	80.9	129.4	203.4	325.4	7,762.5	3,470
Sustainer Engine Cutoff	250.9	87.4	141.1	237.7	380.3	8,321.8	3,720
Atlas Separation	252.8	88.3	142.4	242.2	387.5	8,277.0	3,700
Centaur Engine Start	262.4	92.0	148.4	263.2	421.1	8,254.7	3,690
Centaur Engine Cutoff	716.8	106.5	171.7	1,983.4	3,173.4	24,741.7	11,060
Spacecraft Separation	811.8	155.8	251.3	2,610.6	4,171.0	24,607.4	11,000
Start Centaur Reorientation	1,271.8						
Start Centaur Retrothrust	1,366.8						

* Figures are for launch on May 7. There will be a slight variation for a launch on another day.

Flight Sequence

Flight sequences of the AC-23 and AC-24 rocket vehicles are basically the same with times varying only a second or two in some cases as noted on the accompanying charts. The following sequence description is for AC-24 on May 7.

Atlas Phase

After liftoff, AC-24 will rise vertically for about 15 seconds before beginning its pitch program. Starting at two seconds after liftoff and continuing to T+15 seconds, the vehicle will roll to the desired flight azimuth.

After 148 seconds of flight, the booster engines are shut down (BECO) and jettisoned. BECO occurs when an acceleration of 5.7 g's is sensed by accelerometers on the Centaur and the signal is issued by the Centaur guidance system. The booster package is jettisoned 3.1 seconds after BECO. The Atlas sustainer engine continues to burn for approximately another minute and 43 seconds propelling the vehicle to an altitude of about 87 miles (148 kilometers), attaining a speed of 8,300 mph (3,710 m/s).

Sustainer engine cutoff (SECO) occurs at propellant depletion. Centaur insulation panels and nose fairing are jettisoned prior to SECO.

The Atlas and Centaur stages are then separated. An explosive shaped charge slices through the interstage adapter. Retrorockets mounted on the Atlas slow the spent stage.

Centaur Phase

At four minutes, 22 seconds into the flight, the Centaur's two RL-10 engines ignite for a planned seven-minute 34-second burn. This will place Centaur and the spacecraft on an interplanetary trajectory at a speed of about 24,714 mph (11,050 m/s). After MECO, the Centaur stage and spacecraft are reoriented with the Centaur attitude control thrusters to place the spacecraft on the proper trajectory after separation.

Separation of the Mariner spacecraft is achieved by firing explosive bolts on a V-shaped metal band holding the spacecraft to the adapter. Compressed springs then push the spacecraft away from the Centaur vehicle at a rate of 2.1 feet-per-second (0.6 meters-per-second).

Retromaneuver

Seven and a half minutes after spacecraft separation, the Centaur stage attitude control thrusters are used to reorient the vehicle. The remaining liquid and gaseous propellants are then vented.

The retromaneuver insures that there is no possibility of crashing into the planet and thereby violating the Martian quarantine restraint. The spent Centaur stage will go into a solar orbit. It will pass Mars at a distance of approximately a million miles (1,600,000 kilometers).

LAUNCH OPERATIONS

The Unmanned Launch Operations (ULO) Directorate at the John F. Kennedy Space Center (KSC) is responsible for the preparation and launch of unmanned spacecraft from Florida. For the Mariner '71 missions, ULO will have an added responsibility -- launching two Atlas-Centaur vehicles from Complex 36 within a 10-day period.

The spacecraft are delivered to the Cape from JPL about three months prior to launch and are placed in a clean room environment for final verification tests.

The preparations for these launches are somewhat similar to the Mariner '69 missions which were launched about a month apart. With a tighter launch frame for Mariner '71, the logistics involved in getting both vehicles ready and scheduling of key launch personnel is much more difficult. All of the hardware is fit-checked to assure that it will be adaptable to either vehicle and a pool of spares is established for both.

The key members of the launch team move from one vehicle to the other as required, and a small crew stays with the vehicle not undergoing major testing in order to monitor systems and maintain quality surveillance.

In providing launch operations, KSC handles scheduling of test milestones and review of data to assure that the launch vehicle has met all of its test requirements and is ready for launch.

Because of the relatively short launch opportunity, a special effort was made by the ULO team to develop a work schedule that permits sufficient time to check out both vehicles. Atlas-Centaur No. 23 was erected on Pad 36B in December 1970 and vehicle No. 24 was placed on Pad 36A in February, 1971. Procurement and management of the launch vehicles is directed by the NASA Lewis Research Center.

The Terminal Countdown Demonstration (TCD) was conducted about seven weeks prior to launch using an encapsulated prototype model of the Mariner spacecraft. The TCD primarily demonstrated that all of the functions leading to the actual countdown can be performed. It was an end-to-end check of all systems and included propellant loading of both launch vehicle stages to verify the tanks and facilities were ready for the countdown.

Following this, the Joint Flight Acceptance Composite Test (J-FACT) was conducted about six weeks before launch to assure that the vehicle was electrically ready for final launch preparations and that the proper connections were made with the spacecraft. The J-FACT included running the computer and programmer through post flight events and monitoring the data to assure correct response to all signals with the umbilical ejected.

After AC-24 was erected and the basic systems were checked out, the prototype model was transferred over from AC-23. The TCD on this vehicle was conducted about six weeks prior to its launch, followed by the J-FACT a week later.

In late April, the Mariner H spacecraft was mated on AC-24 and an electrical and mechanical test was conducted prior to running a second J-FACT. Mariner I was encapsulated but will not be mated to AC-23 until Mariner H is successfully launched.

At this point, it would have been possible to launch either space vehicle on either of the two missions. However, AC-24 was selected for the first mission and an electrical-mechanical test and a second J-FACT is scheduled in early May for AC-23 as an added assurance for a successful flight.

The Countdown Readiness Test is scheduled for both space vehicles about four days before launch. It verifies the ability of the launch vehicle to go through post-liftoff events and revalidates the umbilical system. The range support elements participate along with the spacecraft and launch vehicle just as during a launch.

The F-1 Day Functional Test involves final preparations in getting the entire space vehicle ready for launch, preparing ground support equipment, completing readiness procedures and installing ordnance on the launch vehicle.

The final countdown is picked up at T-450 minutes. All systems are checked against readiness procedures, establishing the integrity of the vehicle and ground support equipment interface prior to tower removal at T-120 minutes. Loading of cryogenic propellants (liquid oxygen and liquid hydrogen) begins at T-80 minutes, culminating in complete vehicle readiness at T-5 minutes. The terminal count begins monitoring all systems and topping off and venting propellant and purge systems. At T-10 seconds, the automatic release sequence is initiated and the space vehicle is clear for liftoff.

TRACKING AND DATA SYSTEM AND MISSION OPERATIONS

With facilities located around the Earth and some new items of equipment, NASA's Deep Space Network (DSN) will be able to support both Mariner '71 spacecraft almost continually through their six and one half month flight to Mars and 90-days in orbit for the basic mission, plus overlapping station coverage during critical events.

All DSN stations are equipped with new telemetry equipment capable of receiving, data synchronizing, decoding and processing the high-rate telemetry. Some telecommunications can be received at very high bit rates.

The network is tied to the Space Flight Operations Facility (SFOF), the Mariner nerve center at JPL, by NASA's Communications Network (NASCOM). New data links permit real-time transmission of nearly all data from the twin spacecraft to the SFOF.

Scientists and engineers seated at consoles in the SFOF will have pushbutton control of the displayed information either on television screens in the consoles or on projection screens and automatic plotters and printers. The processed information will be stored in the computer system, available on command.

Tracking and obtaining data from Mariners are part of the mission assigned to JPL. These tasks cover all phases of the flight, including telemetry from launch vehicle and spacecraft, tracking data on both launch vehicle and the Mariners, command signals and the delivery of data to SFOF.

In the launch phase of the mission, tracking will be carried out by DSN with aid of other facilities. These are radars of Air Force Eastern Test Range and downrange elements of NASA's Manned Space Flight Network (MSFN) together with the tracking ship Vanguard and an instrumented jet aircraft. Both ship and jet are operated by MSFN.

The mission is complicated by the fact that Mars, positioned 60 million miles from Earth at time of first encounter, will move beyond 100 million miles through the course of the long mission. Meanwhile, both planets continue moving in their separate orbits and turning on their axes.

The DSN consists of nine specialized tracking facilities located at four points around the Earth. Largest of these, at Goldstone, CA, has two 85-foot (26-meter) antennas and one measuring 210 feet (64-meters) in diameter. Other 85's are at Madrid (Robledo deChavela and Cebreros), Spain; Johannesburg, South Africa; and Woomera and Canberra (Tidbinbilla) Australia. In addition a four-foot (1.2-meter) antenna at Cape Kennedy covers pre-launch and launch phases of the flight.

For all of NASA's unmanned missions in deep space, such as planetary and Sun-orbiting spacecraft, the network provides the tracking information on course and direction of the flight, velocity and range from Earth. It also receives engineering and science telemetry, including planetary television coverage, and sends commands for spacecraft operations. All communication links are in the S-band.

The 210-foot (64-meter) antenna at Goldstone, capable of receiving eight times the volume of data of the other antennas, will play a special role in Mariner '71. The 210 will transfer, on a daily basis, Mars TV pictures obtained and stored in each orbit of the planet.

DSN will support the three months of basic orbital operations by acquiring data telemetered from the spacecraft at 16,200 bits per second through the 210-foot (64-meter) antenna. (Rates with the 85's are 2,025 bits per second.) Data will be routed immediately to SFOF, distributed to computers and other specialized processing machinery, to make it ready for the experimenters.

At the same time spacecraft range and range-rate information will be relayed from both Mariners to SFOF.

A new 50,000 bps digital wideband communications line will carry data from Goldstone to SFOF. High-speed data links from all stations are capable of 4,800 bps. These new data links allow real-time transmission of almost all data from both spacecraft to JPL-SFOF.

The planning and analysis functions of Mariner '71 are carried out by special teams of engineers, including a DSN Mission Operations Team and a DSN Project Engineering Team. The Operations team is responsible not only for the operation of the Network but coordination of near-Earth phase assistance and NASCOM support. The other team has charge of resources, operations planning and configuration control.

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All of NASA's networks are under the direction of the Office of Tracking and Data Acquisition. JPL manages the DSN, while the MSFN facilities and NASCOM are managed by NASA's Goddard Space Flight Center, Greenbelt, MD.

The Goldstone DSN stations are operated and maintained by JPL with the assistance of the Philco-Ford Corp.

The Woomera and Tidbinbilla stations are operated by the Australian Department of Supply.

The Johannesburg station is operated by the South African government through the National Institute for Telecommunications Research.

The two stations near Madrid are operated by the Spanish government's Instituto Nacional de Tecnica Aerospacial (INTA).

Mission Operations

The Space Flight Operations Facility, designed for 24-hour-a-day functioning and equipped to handle multiple spaceflight missions concurrently, is manned by Mission Operations System (MOS) personnel of JPL and Philco-Ford Corp.

Mission operations planning and analysis functions are carried out by five teams, including the DSN Project Engineering Team:

A Navigation Team whose principal functions are spacecraft navigation and scan geometry analysis.

A Spacecraft Team whose principal functions are spacecraft systems performance evaluation and prediction through telemetry data analysis, and the development of alternative methods of utilizing the spacecraft to satisfy mission requirements.

A Science Data Handling Team to collect and coordinate science data processing requirements and to assemble and disseminate data from a data library.

A Science Recommendation Team to analyze science data and recommend science operations plans and priorities.

Real-time mission operations execution is conducted by three teams, including the DSN Mission Operations Team:

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MARINER MARS '71 TEAM

Office of Space Science and Applications

Dr. John E. Naugle	Associate Administrator for OSSA
Vincent L. Johnson	Deputy Associate Administrator for OSSA
Robert S. Kraemer	Director, Planetary Programs
Earl W. Glahn	Mariner '71 Program Manager
Kenneth L. Wadlin	Mariner '71 Program Engineer
Harold F. Hipsher	Mariner '71 Program Scientist
Joseph B. Mahon	Director, Launch Vehicle Programs
T. Bland Norris	Manager, Medium Launch Vehicles
F. Robert Schmidt	Manager, Atlas-Centaur

Office of Tracking and Data Acquisition

Gerald M. Truszynski	Associate Administrator for OTDA
Arnold C. Belcher	Network Operations
Maurice E. Binkley	Network Support

Jet Propulsion Laboratory, Pasadena, CA

Dr. William H. Pickering	Laboratory Director
Adm. John E. Clark	Deputy Laboratory Director
Robert J. Parks	Assistant Laboratory Director for Flight Projects
Dan Schneiderman	Project Manager
James F. McGee	Assistant Project Manager (Near Earth)

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Edwin Pounder	Assistant Project Manager (Near Planet)
Robert Forney	Spacecraft System Manager
Patrick J. Rygh	Mission Operations System Manager
Norman Haynes	Mission Analysis and Engineering Manager
Robert Steinbacher	Project Scientist
Bradford Houser	Project Control and Administration Manager
Dr. Nicholas A. Renzetti	Tracking and Data System Manager
Richard Laeser	Deep Space Network Manager
Richard T. Hayes	Chief of Mission Operations
Al Conrad	Spacecraft Systems Engineer

<u>Lewis Research Center, Cleveland</u>

Bruce T. Lundin	Center Director
Seymour C. Himmel	Director for Rockets and Vehicles
Edmund R. Jonash	Chief, Launch Vehicles Division
Daniel J. Shramo	Atlas-Centaur Project Manager
Edwin Muckley	Centaur Project Engineer

<u>Kennedy Space Center, Florida</u>

Dr. Kurt H. Debus	Center Director
John J. Neilon	Director, Unmanned Launch Operations (ULO)
John D. Gossett	Chief, Centaur Operations Branch, ULO
Donald C. Sheppard	Chief, Spacecraft Operations Branch, ULO

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MARINER MARS 1971 SUBCONTRACTORS

Following is a list of some key subcontractors who provided instruments, hardware and services for the Mariner Mars 1971 Project:

Spacecraft Engineering Subsystem Contracts

Litton Industries Woodland Hills, CA	Data Automation System
Santa Barbara Research Center Goleta, CA	Infrared Radiometer
Electro-Optical Systems Pasadena, CA	Television
University of Colorado Boulder, CO	Ultraviolet Spectrometer
RCA Van Nuys, CA	Science Support Equipment
Philco - WDL Palo Alto, CA	Antenna Assembly
Martin Marietta Denver, CO	Propulsion System
Motorola Phoenix, AZ	Command System
~~Motorola~~ Phoenix, AZ	~~Data Storage Electronics~~
Lockheed Electronics Plainfield, NJ	Data Storage Tape Transport
Motorola Phoenix, AZ	Radio
Texas Instruments Dallas, TX	Telemetry and Infrared Interferometer Spectrometer
General Electric Valley Forge, PA	Attitude Control and Scan Control Electronics

Honeywell Radiation Center Lexington, MA	Canopus Sensor
Motorola Phoenix, AZ	Central Computer & Sequencer
TRW Redondo Beach CA	Batteries
Electro-Optical Systems Pasadena, CA	Power
NAA, Rocketdyne Canoga Park, CA	Engines (Flight)

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